

Sampling and Analysis Plan for the 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units Remedial Investigation/Feasibility Study

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management



U.S. DEPARTMENT OF
ENERGY

Richland Operations
Office

P.O. Box 550
Richland, Washington 99352

*Approved for Public Release;
Further Dissemination Unlimited*

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Date Published
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Release Approval

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Date

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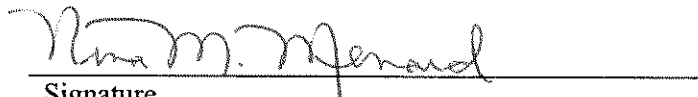
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Terms

ALARA	as low as reasonably achievable
ASTM	American Society for Testing and Materials
bgs	below ground surface
CFR	<i>Code of Federal Regulations</i>
COPC	contaminant of potential concern
CrVI	hexavalent chromium
DOE	U.S. Department of Energy
DQA	data quality assessment
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
EQL	estimated quantitation limit
FS	feasibility study
HASQARD	<i>Hanford Analytical Services Quality Assurance Requirements Document</i>
HEIS	Hanford Environmental Information System database
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RI	remedial investigation
RL	U.S. Department of Energy, Richland Operations Office
SAP	sampling and analysis plan
SVOC	semivolatile organic compound
TPH	total petroleum hydrocarbon
Tri-Party Agreement	<i>Hanford Federal Facility Agreement and Consent Order</i>
VOC	volatile organic compound
WAC	<i>Washington Administrative Code</i>

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1 Introduction

This sampling and analysis plan (SAP) supports the remedial investigation (RI)/feasibility study (FS) process for 100-D/H. The 100-D/H area is located on the Hanford Site in southeastern Washington State and is associated with four source operable units: 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2. The 100-HR-3 Groundwater Operable Unit underlies the four source operable units. This SAP describes the sampling and analysis to be performed associated with environmental investigation wells for soil samples (boreholes), test pits, groundwater monitoring wells, and aquifer tubes within the area. Figure 1-1 shows the location of the planned and existing boreholes, test pits, groundwater monitoring wells, and aquifer tubes within the scope of this SAP. Chapter 2 of DOE/RL-2008-46-ADD1, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan Addendum 1: 100-DR-1, 100-DR-2, 100-H-1, 100-H-2, and 100-H-3 Operable Units* (Addendum 1) describes the site background and environmental setting of the area. Table 1-1 presents the intersection of data needs discussed in Addendum 1 and sampling and analysis activities.

Table 1-1. Plan Activities and Data Needs

Planned Activity	100-D Area		100-H Area		Data Needs No. ^a
	Quantity	Location	Quantity	Location	
New boreholes (vadose zone) ^b	5	116-D-1B Trench 116-D-7 Retention Basin 116-DR-1&2 Trench 116-DR-9 Retention Basin 118-D-6 Reactor Fuel Storage Basin	5	116-H-1 Trench 116-H-4 Pluto Crib 116-H-6 Solar Evaporation Basin 116-H-7 Retention Basin 118-H-6 Reactor Fuel Storage Basin	1, 2, 3, 12
Number of test pits	3	100-D-4 Trench 100-D-12 French Drain 116-D-4 Crib	2	116-H-2 Liquid Waste Trench 1607-H4-Septic Tank and Drain Field	2, 12
New wells to characterize deep vadose zone and unconfined aquifer ^b	5	Well No. 2 Well No. 3 Well No. 4 (116-D-1A) Well No. 5 Well No. 9	5	Well No. 6 Well No. 7 Well No. 10 Well No. 11 Well No. 12	5, 10
New wells to characterize deep vadose zone, unconfined aquifer, Ringold Upper Mud Unit, and Ringold Formation Unit B ^b	2	Well R4 Well R5	3	Well R1 Well R2 Well R3	7, 10, 12
New aquifer tubes	3 tubes at 1 location	Location No. 1	3 tubes at 1 location	Location No. 8	5
Sample spatial/temporal uncertainty groundwater monitoring wells	53 existing locations				13

Table 1-1. Plan Activities and Data Needs

Planned Activity	100-D Area		100-H Area		Data Needs No. ^a
	Quantity	Location	Quantity	Location	

Notes:

This SAP is in addition to field activities described in DOE/RL-2009-09, *Sampling and Analysis Plan for Installation of 100-HR-3 Groundwater Operable Unit Remedial Process Optimization Wells*, and other planned activities.

- a. Data needs are listed in Table 4-6 of DOE/RL-2008-46-ADD1, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan Addendum 1: 100-DR-1, 100-DR-2, 100-H-1, 100-H-2, and 100-H-3 Operable Units*.
- b. Boreholes and groundwater monitoring wells will be logged with a neutron moisture tool and the high-resolution, spectral gamma ray logging system. Geologic samples also will be logged.



Figure 1-1. 100-D/H Area Planned and Existing Sampling Locations

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1.1 Vadose Zone Characterization

This SAP describes activities planned to characterize the vadose zone at 16 waste sites, 10 groundwater monitoring well locations, and 10 borehole locations within 100-D/H. The following waste sites will be characterized by drilling a borehole to groundwater within the waste site boundary:

- 116-D-1A Trench (will be completed as well)
- 116-D-1B Trench
- 116-D-7 Retention Basin
- 116-DR-1&2 Trench
- 116-DR-9 Retention Basin
- 118-D-6 Reactor Fuel Storage Basin
- 116-H-1 Trench
- 116-H-4 Pluto Crib
- 116-H-6 Solar Evaporation Basin
- 116-H-7 Retention Basin
- 118-H-6 Reactor Fuel Storage Basin

Five test pits within waste sites will be excavated, one each at the 100-D-4 Trench, 100-D-12 French Drain, 116-D-4 Crib, 116-H-2 Liquid Waste Trench, and 1607-H4 Septic Tank and Drain Field, to depths of approximately 5.2 to 7.6 m (17 to 25 ft) below ground surface (bgs). Deep vadose zone samples will be collected during drilling of groundwater wells installed as part of the work under the scope of this SAP. Samples will be collected and analyzed to evaluate the nature and extent of contamination at the subject waste sites. Soil samples will not be collected during installation of the two sets of new aquifer tubes associated with the characterization work.

1.2 Groundwater Characterization

Groundwater samples will be collected and analyzed from new and existing groundwater monitoring wells to define the extent of contamination and to support evaluation of contaminant transport. Groundwater sampling from completed wells will be performed in accordance with the field sampling, sample handling, and documentation activities requirements in DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD), volumes 1 through 4. Where possible, new well locations and construction have been selected to satisfy multiple project data needs, such as delineating vadose zone and groundwater contamination.

1.3 Target Analytes and Contaminants of Potential Concern

Method based analysis addresses the suites of analytical methods that will yield results for the target analytes or contaminants of potential concern (COPC). As shown in the Appendix A tables, method based analyses include related analytes in addition to the groundwater COPCs (Table 1-2) and soil/aquifer sediment target analytes (Tables 2-3 through 2-18) reportable by the method. Method based and, where applicable, single component analyses will be performed in accordance with Tables 2-3 through 2-19 for chemical soil/aquifer sediment and water samples analyzed for work performed under this SAP. Results for all methods used will be reported in the Hanford Environmental Information System (HEIS) database. The tables in Appendix A have been provided to define the analytes that will be reported when using a method based analysis approach. In addition, tentatively identified compounds will be reported for

Environmental Protection Agency (EPA) SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*, Methods 8260 and 8270.

1.3.1 Soil/Aquifer Sediment Target Analytes

Process knowledge and existing data were used to compile lists of target analytes specific to individual waste sites. Use of existing data sources to determine these site-specific analyte lists consisted of review of historic and current remediation and characterization documents and data. Appendix B includes the list of historic documents used in the target analyte selection process. Tables 2-3 through 2-18 present the waste site specific target analytes and analytical methods for determination of the analytes.

1.3.2 Groundwater COPCs

Table 1-2 presents the groundwater COPCs and additional analytes for groundwater samples collected under the scope of this SAP. Chapter 4 of DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* (work plan) states the approach used for development of the groundwater COPCs.

Table 1-2. Groundwater Contaminants of Potential Concern and Additional Analytes

Contaminants of Potential Concern			
Radionuclides	Nonradionuclides		
Strontium-90	1,1-Dichloroethene	Copper	Selenium
Technetium-99	Antimony	Fluoride	Silver
Tritium	Arsenic	Hexavalent Chromium	Sulfate
	Benzene	Lead	Thallium
	Beryllium	Manganese	Trichloroethene
	Cadmium	Mercury	Uranium
	Carbon Tetrachloride	Nickel	Vanadium
	Chloroform	Nitrate (as N)	Vinyl Chloride
	Chromium (total)	Nitrite (as N)	Zinc
	Cobalt		
Additional Analytes			
Radionuclides	Nonradionuclides*		
Gross alpha	Cyanide		
Gross beta	Pesticides		
Cesium-137	Polychlorinated biphenyls		
Cobalt-60	Polynuclear aromatic hydrocarbons		
Europium-152	Semivolatile Organic Compounds		
Europium-154			

* Sampling and analysis for semivolatile organic compounds, polynuclear aromatic hydrocarbons, polychlorinated biphenyls, pesticides, and cyanide will take place for select wells and sampling events, as identified in Table 2-19.

1.4 Data Needs

The work plan and Addendum 1 (DOE/RL-2008-46 and DOE/RL-2008-46-ADD1) cover the systematic planning process and its outcome. A systematic planning process, described in Chapter 1 of the work plan, was used to identify 100-D/H data gaps. The problem statement definition was covered in the

systematic planning process. The work plan and Addendum 1 (DOE/RL-2008-46 and DOE/RL-2008-46-ADD1) provide the data needs outcomes from the systematic planning process.

1.5 Sampling Design

The type of sampling design is judgmental sampling (e.g., based on prior knowledge, professional judgment, and expertise). The locations of waste sites, test pits, boreholes, groundwater monitoring wells, and aquifer tubes were defined to address the uncertainties and data needs identified during systematic planning. Figure 1-1 shows the locations of planned and existing sampling locations described in this SAP. Table 2-2 presents the parameters and performance requirements for downhole geophysical logging of boreholes and wells during drilling. Tables 2-3 through 2-19 present the analytical methods selected to meet the estimated quantitation limits (EQLs) and the analytical performance requirements.

1.6 Project Schedule

The 100-D/H Area RI field efforts will occur between October 2009 and June 2010. The drilling lead will prepare the relative borehole and groundwater well schedule for new installations. Samples for a spatial and temporal uncertainty sample round, or event, will be collected for each seasonal “high,” “low,” and “transition” river stages, for a total of three samples per well. Aquifer tube samples will also be collected at seasonal “high,” “low,” and “transition” river stages, for a total of three samples per aquifer tube. Each round of monitoring in the network of wells and aquifer tubes for this area will be completed within 30 consecutive calendar days to minimize statistical variability in water levels. The RI Report will document the results provided by sampling and analysis in this plan.

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2 Quality Assurance Project Plan

This quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection, including planning, implementation, and assessment of sampling, field measurements, and laboratory analysis. This QAPjP complies with the requirements of the following:

- DOE/RL-96-68 (HASQARD)
- DOE O 414.1C, *Quality Assurance*
- 10 *Code of Federal Regulations* (CFR) 830, “Nuclear Safety Management,” Subpart A, “Quality Assurance Requirements”
- EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5

Sections 6.5 and 7.8 of Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan* (Tri-Party Agreement Action Plan), require that quality assurance (QA)/quality control (QC) and sampling and analysis activities specify the QA requirements for treatment, storage, and disposal units, as well as past-practice processes. Therefore, this QAPjP follows the QA elements of EPA QA/R-5 (EPA/240/B-01/003). The QAPjP demonstrates conformance to Part B requirements of ANSI/ASQ E4-2004, *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use*.

In addition to the requirements cited previously, EPA-505-B-04-900A, *Intergovernmental Data Quality Task Force Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs Part 1: UFP-QAPP Manual* (UFP-QAPP) was used as a resource for identifying QAPjP elements.

The UFP-QAPP (EPA-505-B-04-900A) is not imposed through Ecology et al., 1989a, *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement). However, this document is a valuable resource and provides a comprehensive treatment of quality elements that should be addressed in any SAP. The UFP-QAPP (EPA-505-B-04-900A) also was designed to be compatible with EPA QA/R-5 (EPA/240/B-01/003), which forms the basis for this QAPjP.

The QAPjP is divided into the following four sections, which describe the quality requirements and controls applicable to this investigation.

Section 2.1 Project Management – This section addresses project management, including the project history and objectives, and roles and responsibilities of the participants. These elements ensure the project has defined goals, participants understand the goals and the approaches to be used, and planning outputs are documented.

Section 2.2 Data Generation and Acquisition – This section addresses aspects of project design and implementation. Implementing these elements ensures appropriate methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are employed and are properly documented.

Section 2.3 Assessment and Oversight – This section addresses the activities for assessing the effectiveness of implementing the project and associated QA/QC activities. The purpose of assessment is to ensure the QAPjP is implemented as prescribed.

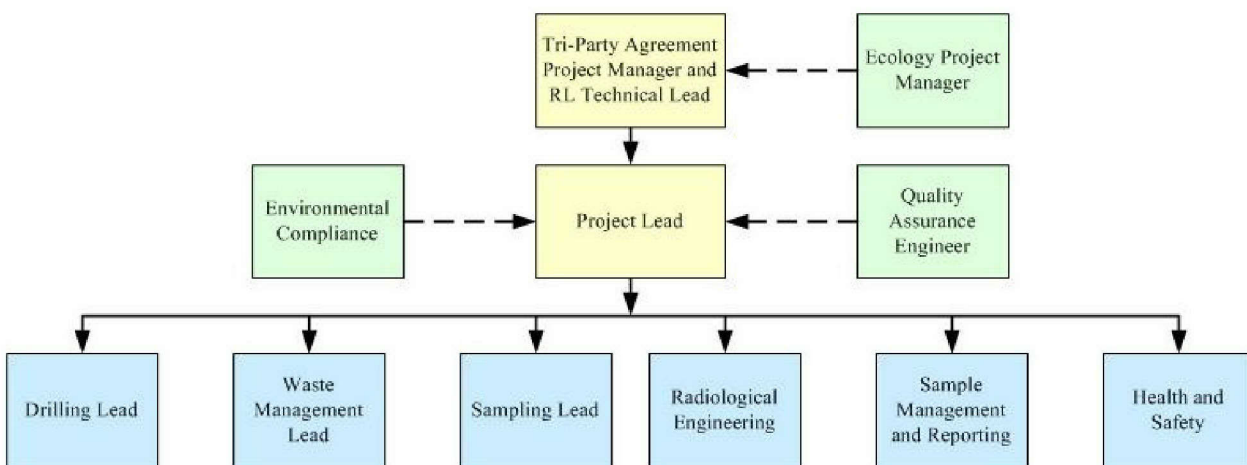
Section 2.4 Data Validation and Usability – This section addresses the QA activities occurring after the data collection or generation phase of the project is completed. Implementing these elements ensures data conform to the specified criteria, thus achieving the project objectives.

2.1 Project Management

The following sections address the basic aspects of project management, ensuring the project has defined goals, the project team understands the goals and the approaches used, and the planned outputs are appropriately documented. Project management roles and responsibilities discussed in this section apply to the major activities covered under this SAP.

2.1.1 Project and Task Organization

The Plateau Remediation Contractor and River Corridor Contractor, or its approved subcontractor, are responsible for planning, coordinating, sampling, preparing, packaging, and shipping samples to the laboratory. The following sections describe the project organization concerning sampling and characterization, also shown in Figure 2-1. The project lead maintains a list of individuals or organizations as points of contact for each functional element in the figure. For each functional primary contractor role, a corresponding oversight role exists within the U.S. Department of Energy (DOE).



Ecology	=	Washington State Department of Ecology
RL	=	U.S. Department of Energy, Richland Operations Office
Tri-Party Agreement	=	Ecology et al., 1989a, <i>Hanford Federal Facility Agreement and Consent Order</i>

Figure 2-1. Project Organization

Ecology Project Manager. The Washington State Department of Ecology (Ecology) has assigned project managers responsible for overseeing the cleanup projects and activities. Ecology has approval authority as the lead regulatory agency for the work being performed under this SAP. Ecology will work with the U.S. Department of Energy, Richland Operations Office (RL) to resolve concerns regarding the work described in this SAP in accordance with the Tri-Party Agreement (Ecology et al., 1989a).

Tri-Party Agreement Project Manager and RL Technical Lead. The Tri-Party Agreement Project Manager is responsible for authorizing RI/FS activities for the 100 Area Operable Units. The Tri-Party Agreement Project Manager also is responsible for obtaining lead regulatory approval of the work plan and SAP that authorize the RI/FS activities under the Tri-Party Agreement. The RL technical lead is responsible for overseeing the contractor in performing the work scope, working with the contractor and the regulatory agencies to identify and work through issues, and providing technical input to the Tri-Party Agreement Project Manager.

Environmental Compliance. The environmental compliance officer provides technical guidance, direction, and acceptance of project and subcontracted environmental work and develops appropriate mitigation measures with a goal of minimizing adverse environmental impacts. The environmental compliance officer also reviews plans, procedures, and technical documents to ensure that environmental requirements have been addressed; identifies environmental issues affecting operations and develops cost-effective solutions; and responds to environmental and regulatory issues or concerns raised by RL and/or the regulatory agencies. The environmental compliance officer also may oversee project implementation for compliance with applicable internal and external environmental requirements.

Project Lead. The project lead is responsible for managing sampling documents and requirements, field activities, and subcontracted tasks, and for ensuring the project file is properly maintained. The project lead ensures that the sampling design requirements are converted into field instructions (e.g., work packages) providing specific direction for field activities. The project lead works closely with QA, Health and Safety, the drilling lead, and the sampling lead to integrate these and other lead disciplines in planning and implementing the work scope. The project lead maintains a list of individuals or organizations filling each of the functional elements of the project organization (Figure 2-1). In addition, the project lead is responsible for version control of the SAP to ensure that personnel are working to the most current job requirements. The project lead also coordinates with RL and primary contractor management on sampling activities. The project lead supports RL in coordinating sampling activities with the regulators.

Quality Assurance Engineer. The QA point of contact is matrixed to the project lead and is responsible for QA issues on the project. Responsibilities include, as appropriate, overseeing implementation of the project QA requirements; reviewing project documents, including the data needs summary reports, the field sampling plan, and the QAPjP; and participating in QA assessments on sample collection and analysis activities. The QA point of contact must be independent of the unit generating the data.

Drilling Lead. The drilling lead has overall responsibility for planning, coordinating, and executing drilling activities. Specific responsibilities include coordinating with the geological and drilling contractors. The drilling lead also communicates with the project lead designee to identify field constraints or emergent conditions affecting sampling design or execution, and directs the procurement and installation of materials and equipment needed to support fieldwork.

Waste Management Lead (Waste Coordinator). The waste management lead communicates policies and procedures and ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost-effective manner. In addition, Waste Management is responsible for identifying waste management sampling and characterization requirements to ensure regulatory compliance, interpreting the characterization data to generate waste designations and profiles, and preparing and maintaining other documents that confirm compliance with waste acceptance criteria.

Sampling Lead. The sampling lead has overall responsibility for planning, coordinating, and executing sampling activities. Specific responsibilities include converting the sampling design requirements into field task instructions providing specific direction for field activities, as well as directing training, mock-ups, and practice sessions with field personnel to ensure the sampling design is understood and can be performed as specified. The sampling lead also communicates with the project lead designee to identify field constraints or emergent conditions affecting sampling design or execution, directs the procurement and installation of materials and equipment needed to support fieldwork, and prepares data packages based on instructions from the project lead designee and information contained in this SAP. The shipping lead reports to the sampling lead for shipment authorization. No sample material will be transported on or off the Hanford Site without permission from an authorized shipper or designee.

Radiological Engineering. The Radiological Engineering lead is responsible for the radiological/health physics support within the project. Specific responsibilities include conducting as low as reasonably achievable (ALARA) reviews, exposure and release modeling, and radiological controls optimization for work planning. In addition, the Radiological Engineering lead identifies radiological hazards and implements appropriate controls to maintain worker exposures ALARA (e.g., requiring personal protective equipment). The Radiological Engineering lead also interfaces with the project Health and Safety contact, and plans and directs radiological control technician support for activities.

Sample Management and Reporting. Sample Management and Reporting coordinates laboratory analytical work, ensuring the laboratories conform to Hanford Site internal laboratory QA requirements, or their equivalent, as approved by DOE, the EPA, and Ecology. Sample Management and Reporting receives analytical data from the laboratories, performs data entry into HEIS, and arranges for data validation. Sample Management and Reporting is responsible for informing the project lead of any issues reported by the analytical laboratory. Sample Management and Reporting develops and oversees the implementation of the letter of instruction to the analytical laboratories, oversees data validation, and works with the project lead to prepare a characterization report on the sampling and analysis results.

The Sample Management and Reporting organization is also responsible for performing the data needs process, or equivalent. Additional related responsibilities include developing the SAP, including documenting the data needs and the sampling design, preparing associated presentations, resolving technical issues, and preparing revisions to the SAP. Samples collected in the field and released to the River Corridor Closure Contractor for shipping and analysis, as well as the resulting data, will be managed in accordance with applicable procedures and work plans.

Laboratories. The laboratories analyze samples in accordance with established procedures, provide necessary sample reports, and explain results in support of data validation. The laboratories must meet site-specific QA requirements and must have an approved QA plan in place.

Health and Safety. Health and Safety is responsible for coordinating industrial safety and health support within the project, as carried out through health and safety plans, job hazard analyses, and other pertinent safety documents required by federal regulation or by internal primary contractor work requirements. In addition, Health and Safety assists project personnel in complying with applicable health and safety standards and requirements. Health and Safety coordinates with Radiological Engineering to determine personal protective clothing requirements.

2.1.2 Problem Definition and Background

This SAP describes the sampling and analysis to be performed associated with boreholes, test pits, groundwater monitoring wells, and aquifer tubes for the 100-D/H Area. The specific problems to be solved, background information, and general information are provided in the work plan and Addendum 1. Media to be sampled include water, aquifer sediment, and soil. Figure 1-1 shows the location of the planned and existing boreholes, test pits, groundwater monitoring wells, and aquifer tubes within the scope of this SAP. The regulatory drivers and reference to agreement documents for an activity are provided in the work plan.

2.1.3 Project and Task Description

Chapter 3 presents the field sampling plan. Tables 1-2 presents the groundwater COPCs and additional analytes. Tables 2-3 through 2-18 provide the site-specific soil/aquifer sediment target analytes. Section 1.6 provides guidance on the implementation schedule.

2.1.4 Quality Objectives and Criteria

The QA objective of this plan is to develop implementation guidance for providing data of known and appropriate quality. Data quality indicators describe data quality by evaluation against identified data needs and the work activities identified in this SAP. The applicable QC guidelines, EQLs, and levels of effort for assessing data quality are dictated by the intended use of the data and the nature of the analytical method. The principal data quality indicators are precision, bias or accuracy, representativeness, comparability, completeness, and sensitivity. These data quality indicators are defined for the purpose of this document in Table 2-1. The data quality indicators will be evaluated during the data quality assessment (DQA) process (Section 2.4.3).

Table 2-2 presents the analytical performance requirements for the downhole geophysical logging of boreholes and wells during drilling. Tables 2-3 through 2-18 present analytical performance requirements for soil/aquifer sediment samples by location. Ecological screening values are presented in Appendix C for reference. Table 2-19 presents analytical performance requirements for water samples based on the COPCs in Table 1-2. Laboratory operations and analytical services will be in compliance with Volume 4 of HASQARD (DOE/RL-96-68) and specific criteria identified in Tables 2-2 through 2-19. The criteria in Tables 2-2 through 2-19 take precedence over similar criteria in HASQARD. In consultation with the laboratory, the project lead and/or others, as appropriate, Sample Management and Reporting can approve changes to analytical methods as long as the method is based upon a nationally recognized (e.g., EPA, American Society for Testing and Materials [ASTM]) method, the new method achieves project data quality objectives (DQOs) as well as or better than the replaced method, and the new method is required due to the nature of the sample (e.g., high radioactivity).

Table 2-1. Data Quality Indicators

Data Quality Indicator	Definition	Example Determination Methodologies	Project-Specific Information*	Corrective-Action Examples
Precision	<p>The measure of agreement among repeated measurements of the same property under identical or substantially similar conditions; calculated either as the range or as the standard deviation.</p> <p>May also be expressed as a percentage of the mean of the measurements, such as relative range, relative percent difference, or relative standard deviation (coefficient of variation).</p>	<p>Use the same analytical instrument to make repeated analyses on the same sample.</p> <p>Use the same method to make repeated measurements of the same sample within a single laboratory or have two or more laboratories analyze identical samples with the same method.</p> <p>Split a sample in the field and submit both for sample handling, preservation and storage, and analytical measurements.</p> <p>Collect, process, and analyze co-located samples for information on sample acquisition, handling, shipping, storage, preparation, and analytical processes and measurements.</p>	<p>Field precision: At randomly selected locations, duplicate samples will be taken 1 per 20 samples per media.</p> <p>Laboratory precision: Analysis of laboratory duplicate or matrix spike duplicate results.</p>	<p>If duplicate data do not meet objective:</p> <ul style="list-style-type: none"> Evaluate apparent cause (e.g., sample heterogeneity). Request reanalysis or re-measurement. Qualify the data before use.
Accuracy	<p>A measure of the overall agreement of a measurement to a known value; includes a combination of random error (precision) and systematic error (bias) components of sampling and analytical operations.</p>	<p>Analyze a reference material or reanalyze a sample to which a material of known concentration or amount of pollutant has been added (a spiked sample); usually expressed either as percent recovery or as a percent bias.</p>	<p>Laboratory accuracy determination based on matrix spike and matrix spike duplicate results.</p>	<p>If recovery does not meet objective:</p> <ul style="list-style-type: none"> Qualify the data before use. Request reanalysis or re-measurement.

Table 2-1. Data Quality Indicators

Data Quality Indicator	Definition	Example Determination Methodologies	Project-Specific Information*	Corrective-Action Examples
Representativeness	A qualitative term to express "the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition." (ANSI/ASQC S2-1995)	Evaluate whether measurements are made and physical samples collected in such a manner that the resulting data appropriately reflect the environment or condition being measured or studied.	Samples will be collected as described in the sampling design. Judgmental sampling ensures areas most likely to be contaminated, based on current information, will be evaluated.	If results are not representative of the system sampled: <ul style="list-style-type: none"> Identify the reason result is not representative. Reject the data, or, if data are otherwise usable, qualify the data for limited use and define the portion of the system the data represent. Redefine sampling and measurement requirements and protocols. Resample and reanalyze.
Comparability	A qualitative term expressing the measure of confidence with which one data set can be compared to another and can be combined for the decision(s) to be made.	Compare sample collection and handling methods, sample preparation and analytical procedures, holding times, stability issues, and QA protocols.	Sampling personnel will use the same sampling protocols. Samples will be submitted to the same laboratories when possible (based on laboratory contracts) for analysis by the same methods, thus data results will be comparable.	If data are not comparable to other data sets: <ul style="list-style-type: none"> Identify appropriate changes to data collection and/or analysis methods. Identify quantifiable bias, if applicable. Qualify the data as appropriate. Resample and/or reanalyze, if needed. Revise sampling/analysis protocols to ensure future comparability.

Table 2-1. Data Quality Indicators

Data Quality Indicator	Definition	Example Determination Methodologies	Project-Specific Information*	Corrective-Action Examples
Completeness	A measure of the amount of valid data needed to be obtained from a measurement system.	Compare the number of valid measurements completed (samples collected or samples analyzed) with those established by the project's data needs.	The percent complete will be determined during data validation.	<p>If data set does not meet completeness objective:</p> <ul style="list-style-type: none"> Identify appropriate changes to data collection and/or analysis methods. Identify quantifiable bias, if applicable. Qualify the data as appropriate. Resample and/or reanalyze, if needed. Revise sampling/analysis protocols to ensure future comparability.
Sensitivity	The capability of a method or instrument to discriminate among measurement responses representing different levels of the variable of interest.	Determine the minimum concentration or attribute to be measured by a method (method detection limit), by an instrument (instrument detection limit), or by a laboratory (quantitation limit). The practical quantitation limit is the lowest level that can be routinely quantified and reported by a laboratory.	Ensure that sensitivity, as measured by detection limits, is appropriate for the action levels.	<p>If sensitivity does not meet objective:</p> <ul style="list-style-type: none"> Request reanalysis or re-measurement. Qualify/reject the data before use.

Notes:

* Field sampling requirements are noted. Laboratories will follow requirements for use and interpretation of laboratory control samples.

ANSI/ASQC S2-1995, *Introduction to Attribute Sampling*

Table 2-2. Downhole Geophysical Logging Analytical Performance Requirements

Analyte	Analytical Method	Vertical Resolution	Count Time	Action Level	Detection Limit	Accuracy Requirement (%)	Precision Requirement (%)
Spectral Gamma – Logging System (HPGe)							
Potassium-40	HPGe	6 inches	200 seconds	N/A ^a	0.1 pCi/g	80-120	±20 ^a
Thorium-232 (Thallium-208)	HPGe	6 inches	200 seconds	N/A ^a	0.1 pCi/g	80-120	±20 ^a
Uranium-235	HPGe	6 inches	200 seconds	N/A ^a	0.6 pCi/g	80-120	±20 ^a
Uranium-238 (Bismuth-214)	HPGe	6 inches	200 seconds	N/A ^a	0.1 pCi/g	80-120	±20 ^a
Uranium-238 (Paladium-234m)	HPGe	6 inches	200 seconds	N/A ^a	10 pCi/g	80-120	±20 ^a
Neutron Moisture – Logging System							
Hydrogen content by backscattered neutrons	Neutron moisture probe	3 inches	15 seconds	N/A ^a	0.5% moisture	80-120 ^b	±20

Notes:

a. Depends on field conditions. Factors that affect this value include degree of Compton scattering and peak-to-peak measurements.

b. Accuracy degrades at lower moisture levels.

N/A = not applicable

pCi/g = picoCuries per gram

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 100-D-12

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Field Measurements ^d								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	— ^e
12587-46-1	Gross alpha	100 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e
12587-47-2	Gross beta	5,000 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e
Performance Requirements for Laboratory Measurements (Radiological)								
10098-97-2	Strontium-90 ^{f,g}	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30 ^h	70-130 ^h
14133-76-7	Technetium-99 ^g	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC – Technetium-99	≤30 ^h	70-130 ^h
10028-17-8	Tritium ^g	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC – Tritium	≤30 ^h	70-130 ^h
13967-70-9	Cesium-134	0.1 pCi/g	N/A	N/A	N/A	Gamma energy analysis	≤30 ^h	70-130 ^h
10045-97-3	Cesium-137 ^g	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g			
10198-40-0	Cobalt-60 ^g	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV ⁱ	NV ⁱ			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV ⁱ	NV ⁱ			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV ⁱ	NV ⁱ			
—	Uranium-233/234 ^j	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g	Isotopic – Uranium	≤30 ^h	70-130 ^h
15117-96-1	Uranium-235 ^k	0.5 pCi/g ^l	0.61 pCi/g	0.185 pCi/g	0.185 pCi/g			
—	Uranium-238 ^j	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g			

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 100-D-12

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Laboratory Measurements (Nonradiological)								
—	pH	0.5 pH unit	N/A	N/A	N/A	EPA 9045 or 160.1	≤30	N/A
16984-48-8	Fluoride	5 mg/kg	4,800 mg/kg	2,880 mg/kg	5,770 mg/kg	EPA 300.0 (anions by IC)	≤30 ^m	70-130 ^m
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg			
14797-65-0	Nitrite (as N)	2.5 mg/kg	8,000 mg/kg	4 mg/kg	8 mg/kg			
14808-79-8	Sulfate	5 mg/kg	NV	1,030 mg/kg	2,060 mg/kg			
7440-36-0	Antimony	6 mg/kg ⁿ	32 mg/kg	5.4 mg/kg	25.3 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30 ^m	70-130 ^m
7440-38-2	Arsenic ^o	10 mg/kg	TBD	TBD	TBD			
7440-39-3	Barium	2 mg/kg	16,000 mg/kg	1,650 mg/kg	3,300 mg/kg			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-43-9	Cadmium	0.5 mg/kg ⁿ	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese ^p	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 100-D-12

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg ⁿ	400 mg/kg	5.2 mg/kg	1.04 mg/kg			
7440-22-4	Silver	1 mg/kg ⁿ	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg ⁿ	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-62-2	Vanadium	2.5 mg/kg	560 mg/kg	2,240 mg/kg	NV			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 (mercury by cold vapor)	≤30 ^m	70-130 ^m
18540-29-9	Hexavalent chromium ^q	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Hexavalent chromium)	≤30 ^m	70-130 ^m
71-43-2	Benzene	0.005 mg/kg ^l	18.2 mg/kg	0.00448 mg/kg	0.014 mg/kg	EPA 8260 (volatile organic compounds)	≤30 ^r	70-130 ^r
56-23-5	Carbon tetrachloride	0.005 mg/kg ^l	7.69 mg/kg	0.031 mg/kg	0.0046 mg/kg			
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
75-35-4	1,1-Dichloroethene	0.01 mg/kg ^l	1.67 mg/kg	0.0005 mg/kg	0.0008 mg/kg			
79-01-6	Trichloroethene	0.005 mg/kg ^l	11.2 mg/kg	0.00323 mg/kg	0.0355 mg/kg			
75-01-4	Vinyl Chloride	0.01 mg/kg ^l	0.667 mg/kg	0.00018 mg/kg	0.0252 mg/kg			
7440-61-1	Uranium (total) ^s	1 mg/kg	240 mg/kg	3.21 mg/kg	3.21 mg/kg	UKPA or via isotopic	≤30 ^m	70-130 ^m

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 100-D-12

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7440-38-2	Arsenic	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-39-3	Barium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-43-9	Cadmium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-47-3	Chromium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
18540-29-9	Hexavalent chromium	3.7 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 7196	≤30 ^m	70-130 ^m
7439-92-1	Lead	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-22-4	Silver	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7782-49-2	Selenium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 100-D-12

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Physical Properties								
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937	N/A	N/A

Notes:

- Unless otherwise noted, Preliminary Cleanup Goals are established in the Washington Administrative Code (WAC) 173-340, "Model Toxics Control Act – Cleanup," 2007.
- Value includes a groundwater-to-river dilution attenuation factor of 2 based on the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE/RL-96-17, Rev. 6). A task is included in the *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* (DOE/RL-2008-46) to evaluate the appropriate dilution attenuation factor. Other considerations for analysis include WAC 173-340-730 (6)(b) (2007).
- Equivalent methods may be substituted. For EPA Method 300.0, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*. For EPA Method 200.8, see EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.
- Soil will be logged with a neutron moisture tool and the high resolution, spectral gamma ray logging system. Geologic samples will also be logged. Vadose zone soil samples will be field-screened for gross alpha, gross beta, and gross gamma activities. Aquifer sediment samples will be field-screened for gross gamma activity.
- Field measurements have no specific QC requirement for accuracy except to perform checks to verify manufacturer's expected performance.
- Strontium-90 will be assessed as total radioactive strontium.

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 100-D-12

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
<p>g. The groundwater protection and river protection preliminary cleanup goal values for cesium-137, cobalt-60, technetium-99, tritium, and strontium-90 were established in DOE/RL-96-17, <i>Remedial Design Report/Remedial Action Work Plan for the 100 Area</i>, Revision 6.</p> <p>h. Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.</p> <p>i. Generic RESRAD modeling reported in DOE/RL-96-17, <i>Remedial Design Report/Remedial Action Work Plan for the 100 Area</i>, predicts the contaminant will not reach groundwater within 1,000 years; however, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.</p> <p>j. The Uranium-233/234 and Uranium-238 groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site Background.</p> <p>k. The Uranium-235 groundwater and river protection preliminary cleanup goal values are based on the recommended daily limit.</p> <p>l. Calculated preliminary cleanup goals are less than established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.</p> <p>m. Accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.</p> <p>n. To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if estimated quantitation limits are met.</p> <p>o. The preliminary cleanup goal value for arsenic will be re-evaluated as described in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i>.</p> <p>p. Manganese groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site background values.</p> <p>q. A task is included in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i> to re-evaluate hexavalent chromium cleanup levels.</p> <p>r. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control limits, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Method 8260.</p> <p>s. The uranium groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site background.</p> <p>ASTM D422-63, <i>Standard Test Method for Particle-Size Analysis of Soils</i>.</p> <p>ASTM D2216-05, <i>Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass</i>.</p> <p>ASTM D2434-68, <i>Standard Test Method for Permeability of Granular Soils (Constant Head)</i>.</p>								

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 100-D-12

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
ASTM D2937-04, <i>Standard Test Method for Density of Soil in Place by Drive-Cylinder Method</i> .								
ASTM D5084-03, <i>Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter</i> .								
µg/L	=	micrograms per liter			MS	=	mass spectroscopy	
ASTM	=	American Society for Testing and Materials			N/A	=	not applicable	
CAS No.	=	Chemical Abstracts Service number			NV	=	no value	
cm ²	=	square centimeters			pCi/g	=	picoCuries per gram	
dpm	=	disintegrations per minute			pH	=	acidity or alkalinity of an aqueous solution	
EPA	=	U.S. Environmental Protection Agency			QC	=	quality control	
IC	=	ion chromatography			RESRAD	=	RESidual RADioactivity (dose model)	
ICP	=	inductively coupled plasma			TBD	=	to be determined	
LSC	=	liquid scintillation counter			UKPA	=	total uranium by kinetic phosphorescence analysis	
mg/kg	=	milligrams per kilogram						

Table 2-4. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 100-D-4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Field Measurements ^d								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	— ^e
12587-46-1	Gross alpha	100 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e
12587-47-2	Gross beta	5,000 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e

Table 2-4. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 100-D-4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Laboratory Measurements (Radiological)								
14596-10-2	Americium-241	1 pCi/g	31.1 pCi/g	NV ^f	NV ^f	Americium-241/ Curium-244	≤30 ^g	70-130 ^g
10045-97-3	Cesium-137 ^h	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	Gamma energy analysis	≤30 ^g	70-130 ^g
10198-40-0	Cobalt-60 ^h	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV ^f	NV ^f			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV ^f	NV ^f			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV ^f	NV ^f			
10098-97-2	Strontium-90 ^{h,i}	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30 ^g	70-130 ^g
13981-16-3	Plutonium-238	1 pCi/g	37.4 pCi/g	NV ^f	NV ^f	Isotopic – Plutonium	≤30 ^g	70-130 ^g
—	Plutonium-239/240	1 pCi/g	33.9 pCi/g	NV ^f	NV ^f			
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV ^f	NV ^f	LSC – Carbon-14	≤30 ^g	70-130 ^g
10028-17-8	Tritium ^h	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC – Tritium	≤30 ^g	70-130 ^g
—	Uranium-238 ^j	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g	Isotopic – Uranium	≤30 ^g	70-130 ^g
13981-37-8	Nickel-63 ^h	30 pCi/g	4,026 pCi/g	83 pCi/g	166 pCi/g	LSC – Nickel-63	≤30 ^g	70-130 ^g
Performance Requirements for Laboratory Measurements (Nonradiological)								
16984-48-8	Fluoride	5 mg/kg	4,800 mg/kg	2,880 mg/kg	5,770 mg/kg	EPA 300.0 (Anions by IC)	≤30 ^k	70-130 ^k
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg			
14797-65-0	Nitrite (as N)	2.5 mg/kg	8,000 mg/kg	4 mg/kg	8 mg/kg			
14808-79-8	Sulfate	5 mg/kg	NV	1,030 mg/kg	2,060 mg/kg			

Table 2-4. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 100-D-4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7440-38-2	Arsenic ^l	10 mg/kg	TBD	TBD	TBD	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30 ^k	70-130 ^k
7440-39-3	Barium	2 mg/kg	16,000 mg/kg	1,650 mg/kg	3,300 mg/kg			
7440-43-9	Cadmium	0.5 mg/kg ^m	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese ⁿ	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7440-22-4	Silver	1 mg/kg ^m	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg ^m	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-62-2	Vanadium	2.5 mg/kg	560 mg/kg	2,240 mg/kg	NV			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			
18540-29-9	Hexavalent chromium ^o	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Hexavalent chromium)	≤30 ^k	70-130 ^k
11097-69-1	Aroclor-1254 (PCB)	0.017 mg/kg ^p	0.5 mg/kg	0.0664 mg/kg	0.000315 mg/kg	EPA 8082 (PCBs by GC)	≤30 ^q	70-130 ^q
11096-82-5	Aroclor-1260 (PCB)	0.017 mg/kg ^p	0.5 mg/kg	0.721 mg/kg	0.00342 mg/kg			

Table 2-4. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 100-D-4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
75-35-4	1,1-Dichloroethene	0.01 mg/kg ^p	1.67 mg/kg	0.0005 mg/kg	0.0008 mg/kg	EPA 8260 (volatile organic compounds)	≤30 ^q	70-130 ^q
67-64-1	Acetone	0.02 mg/kg	72,000 mg/kg	28.9 mg/kg	NV			
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
75-09-2	Methylene chloride	0.005 mg/kg	133 mg/kg	0.218 mg/kg	0.0409 mg/kg			
108-88-3	Toluene	0.005 mg/kg	6,400 mg/kg	4.65 mg/kg	99 mg/kg			
75-01-4	Vinyl Chloride	0.01 mg/kg ^p	0.667 mg/kg	0.00018 mg/kg	0.0252 mg/kg	EPA 8270 (semivolatile organic compounds)	≤30 ^q	70-130 ^q
88-75-5	2-Nitrophenol	0.66 mg/kg	NV	NV	NV			
65-85-0	Benzoic acid	16.5 mg/kg	320,000 mg/kg	257 mg/kg	NV			
117-81-7	Bis(2-ethylhexyl) phthalate	0.33 mg/kg	71.4 mg/kg	13.9 mg/kg	8.01 mg/kg			
85-68-7	Butylbenzyl phthalate	0.33 mg/kg	16,000 mg/kg	893 mg/kg	698 mg/kg			
84-66-2	Diethyl phthalate	0.33 mg/kg	71.4 mg/kg	13.9 mg/kg	8.01 mg/kg			
84-74-2	di-n-Butyl phthalate	0.33 mg/kg	8,000 mg/kg	56.5 mg/kg	191 mg/kg			
87-86-5	Pentachlorophenol	0.33 mg/kg ^p	8.33 mg/kg	0.0158 mg/kg	0.00887 mg/kg			

Table 2-4. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 100-D-4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
120-12-7	Anthracene	0.015 mg/kg	24,000 mg/kg	1,140 mg/kg	9,100 mg/kg	EPA 8310 (polynuclear aromatic hydrocarbons)	≤30 ^q	70-130 ^q
56-55-3	Benzo(a)anthracene	0.015 mg/kg	1.37 mg/kg	0.586 mg/kg	0.04 mg/kg			
50-32-8	Benzo(a)pyrene	0.015 mg/kg	0.137 mg/kg	2.33 mg/kg	0.109 mg/kg			
205-99-2	Benzo(b)fluoranthene	0.015 mg/kg	1.37 mg/kg	2.95 mg/kg	0.138 mg/kg			
191-24-2	Benzo(ghi)perylene	0.03 mg/kg	2,400 mg/kg	25,700 mg/kg	7,070 mg/kg			
207-08-9	Benzo(k)fluoranthene	0.015 mg/kg	1.37 mg/kg	21.5 mg/kg	0.137 mg/kg			
218-01-9	Chrysene	0.1 mg/kg ^p	13.7 mg/kg	9.56 mg/kg	0.0446 mg/kg			
206-44-0	Fluoranthene	0.05 mg/kg	3,200 mg/kg	631 mg/kg	178 mg/kg			
193-39-5	Indeno(1,2,3-cd)pyrene	0.03 mg/kg	1.37 mg/kg	8.33 mg/kg	0.389 mg/kg			
129-00-0	Pyrene	0.05 mg/kg	2,400 mg/kg	655 mg/kg	2,620 mg/kg	UKPA or via isotopic	≤30 ^k	70-130 ^k
7440-61-1	Uranium (total) ^r	1 mg/kg	240 mg/kg	3.21 mg/kg	3.21 mg/kg			
7440-38-2	Arsenic	50 µg/L	N/A	N/A	N/A			
7440-39-3	Barium	50 µg/L	N/A	N/A	N/A			
7440-43-9	Cadmium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^k	70-130 ^k

Table 2-4. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 100-D-4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7440-47-3	Chromium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^k	70-130 ^k
18540-29-9	Hexavalent chromium	3.7 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 7196	≤30 ^k	70-130 ^k
7439-92-1	Lead	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^k	70-130 ^k
7440-22-4	Silver	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals) or EPA 200.8	≤30 ^k	70-130 ^k
7782-49-2	Selenium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^k	70-130 ^k
Performance Requirements for Physical Properties								
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A

Table 2-4. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 100-D-4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937	N/A	N/A

Notes:

- a. Unless otherwise noted, Preliminary Cleanup Goals are established in the Washington Administrative Code (WAC) 173-340, "Model Toxics Control Act – Cleanup," 2007.
- b. Value includes a groundwater-to-river dilution attenuation factor of 2 based on the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE/RL-96-17, Rev. 6). A task is included in the *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* (DOE/RL-2008-46) to evaluate the appropriate dilution attenuation factor. Other considerations for analysis include WAC 173-340-730 (6)(b) (2007).
- c. Equivalent methods may be substituted. For EPA Method 300.0, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*. For EPA Method 200.8, see EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.
- d. Soil will be logged with a neutron moisture tool and the high resolution, spectral gamma ray logging system. Geologic samples will also be logged. Vadose zone soil samples will be field-screened for gross alpha, gross beta, and gross gamma activities. Aquifer sediment samples will be field-screened for gross gamma activity.
- e. Field measurements have no specific QC requirement for accuracy except to perform checks to verify manufacturer's expected performance.
- f. Generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years; however, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.
- g. Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.
- h. The groundwater protection and river protection preliminary cleanup goal values for cesium-137, cobalt-60, tritium, strontium-90, and nickel-63 were established in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Revision 6.
- i. Strontium-90 will be assessed as total radioactive strontium.
- j. The Uranium-238 groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site Background.
- k. Accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.
- l. The preliminary cleanup goal value for arsenic will be re-evaluated as described in DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan*.
- m. To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if estimated quantitation limits are met.

Table 2-4. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 100-D-4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			

- n. Manganese groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site background values.
- o. A task is included in DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* to re-evaluate hexavalent chromium cleanup levels.
- p. Calculated preliminary cleanup goals are less than established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.
- q. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control limits, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Methods 8260 and 8270.
- r. The uranium groundwater and river protection preliminary clean goal values are not risk-based. The values are based on Hanford Site background.

ASTM D422-63, *Standard Test Method for Particle-Size Analysis of Soils*.

ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*.

ASTM D2434-68, *Standard Test Method for Permeability of Granular Soils (Constant Head)*.

ASTM D2937, *Standard Test Method for Density of Soil in Place by Drive-Cylinder Method*.

ASTM D5084-03, *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*.

µg/L = micrograms per liter

ASTM = American Society for Testing and Materials

CAS No. = Chemical Abstracts Service number

cm² = square centimeters

dpm = disintegrations per minute

EPA = U.S. Environmental Protection Agency

GC = gas chromatography

IC = ion chromatography

ICP = inductively coupled plasma

LSC = liquid scintillation counter

mg/kg = milligrams per kilogram

MS = mass spectroscopy

N/A = not applicable

NV = no value

PCB = polychlorinated biphenyl

pCi/g = picoCuries per gram

QC = quality control

RESRAD = RESidual RADioactivity (dose model)

TBD = to be determined

UKPA = total uranium by kinetic phosphorescence analysis

Table 2-5. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-D-1A/116-D-1B

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Field Measurements ^d								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	— ^e
12587-46-1	Gross alpha	100 dpm/ 100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e
12587-47-2	Gross beta	5,000 dpm/ 100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e
Performance Requirements for Laboratory Measurements (Radiological)								
14596-10-2	Americium-241	1 pCi/g	31.1 pCi/g	NV ^f	NV ^f	Americium-241/ Curium-244	≤30 ^g	70-130 ^g
10045-97-3	Cesium-137 ^h	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	Gamma energy analysis	≤30 ^g	70-130 ^g
10198-40-0	Cobalt-60 ^h	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV ^f	NV ^f			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV ^f	NV ^f			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV ^f	NV ^f			
—	Uranium-238 ⁱ	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g	Isotopic – Uranium	≤30 ^g	70-130 ^g
10098-97-2	Strontium-90 ^{h,j}	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30 ^g	70-130 ^g
—	Plutonium-239/240	1 pCi/g	33.9 pCi/g	NV ^f	NV ^f	Isotopic – Plutonium	≤30 ^g	70-130 ^g
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV ^f	NV ^f	LSC – Carbon-14	≤30 ^g	70-130 ^g
13981-37-8	Nickel-63 ^h	30 pCi/g	4,026 pCi/g	83 pCi/g	166 pCi/g	LSC – Nickel-63	≤30 ^g	70-130 ^g

Table 2-5. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-D-1A/116-D-1B

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
14133-76-7	Technetium-99 ^h	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC – Technetium-99	≤30 ^g	70-130 ^g
10028-17-8	Tritium ^h	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC – Tritium	≤30 ^g	70-130 ^g
13994-20-2	Neptunium-237 ^h	1 pCi/g ^k	2.44 pCi/g	0.9 pCi/g	1.80 pCi/g	Atomic energy absorption	≤30 ^g	70-130 ^g
Performance Requirements for Laboratory Measurements (Nonradiological)								
16984-48-8	Fluoride	5 mg/kg	4,800 mg/kg	2,880 mg/kg	5,770 mg/kg	EPA 300.0 (Anions by IC)	≤30 ^l	70-130 ^l
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg			
14797-65-0	Nitrite (as N)	2.5 mg/kg	8,000 mg/kg	4 mg/kg	8 mg/kg			
14808-79-8	Sulfate	5 mg/kg	NV	1,030 mg/kg	2,060 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30 ^l	70-130 ^l
7440-36-0	Antimony	6 mg/kg ^m	32 mg/kg	5.4 mg/kg	25.3 mg/kg			
7440-38-2	Arsenic ⁿ	10 mg/kg	TBD	TBD	TBD			
7440-39-3	Barium	2 mg/kg	16,000 mg/kg	1,650 mg/kg	3,300 mg/kg			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-43-9	Cadmium	0.5 mg/kg ^m	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-48-4	Cobalt ^o	2 mg/kg	24 mg/kg	15.7 mg/kg	NV			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			

Table 2-5. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-D-1A/116-D-1B

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7439-96-5	Manganese ^p	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg ^m	400 mg/kg	5.2 mg/kg	1.04 mg/kg			
7440-22-4	Silver	1 mg/kg ^m	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg ^m	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-62-2	Vanadium	2.5 mg/kg	560 mg/kg	2,240 mg/kg	NV			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 (mercury by cold vapor)	≤30 ^l	70-130 ^l
18540-29-9	Hexavalent chromium ^q	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (hexavalent chromium)	≤30 ^l	70-130 ^l
71-43-2	Benzene	0.005 mg/kg ^k	18.2 mg/kg	0.00448 mg/kg	0.014 mg/kg	EPA 8260 (volatile organic compounds)	≤30 ^r	70-130 ^r
56-23-5	Carbon tetrachloride	0.005 mg/kg ^k	7.69 mg/kg	0.031 mg/kg	0.0046 mg/kg			
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
75-35-4	1,1-Dichloroethene	0.01 mg/kg ^k	1.67 mg/kg	0.0005 mg/kg	0.0008 mg/kg			
75-01-4	Vinyl Chloride	0.01 mg/kg ^k	0.667 mg/kg	0.00018 mg/kg	0.0252 mg/kg			
79-01-6	Trichloroethene	0.005 mg/kg ^k	11.2 mg/kg	0.00323 mg/kg	0.0355 mg/kg			
541-73-1	1,3-Dichlorobenzene	0.01 mg/kg	2,400 mg/kg	3.09 mg/kg	10.3 mg/kg	EPA 8270 (semivolatile organic compounds)	≤30 ^r	70-130 ^r
117-81-7	Bis(2-ethylhexyl) phthalate	0.33 mg/kg	71.4 mg/kg	13.9 mg/kg	8.01 mg/kg			
86-74-8	Carbazole	0.33 mg/kg ^k	50 mg/kg	0.314 mg/kg	NV			
84-74-2	Di-n-butyl phthalate	0.33 mg/kg	8,000 mg/kg	56.5 mg/kg	191 mg/kg			

Table 2-5. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-D-1A/116-D-1B

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
11097-69-1	Aroclor-1254 (PCB)	0.017 mg/kg ^k	0.5 mg/kg	0.0664 mg/kg	0.000315 mg/kg	EPA 8082 (PCB by GC)	≤30 ^r	70-130 ^r
319-85-7	beta-BHC	0.00165 mg/kg	0.556 mg/kg	0.00227 mg/kg	0.00259 mg/kg	EPA 8081 (pesticides by GC)	≤30 ^r	70-130 ^r
60-57-1	Dieldrin	0.0033 mg/kg ^k	0.0625 mg/kg	0.00282 mg/kg	0.000089 mg/kg			
7440-61-1	Uranium (total) ^s	1 mg/kg	240 mg/kg	3.21 mg/kg	3.21 mg/kg	UKPA or via isotopic	≤30 ^l	70-130 ^l
7440-38-2	Arsenic	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^l	70-130 ^l
7440-39-3	Barium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^l	70-130 ^l
7440-43-9	Cadmium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^l	70-130 ^l
7440-47-3	Chromium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^l	70-130 ^l
18540-29-9	Hexavalent chromium	3.7 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 7196	≤30 ^l	70-130 ^l
7439-92-1	Lead	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^l	70-130 ^l
7440-22-4	Silver	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals) or EPA 200.8	≤30 ^l	70-130 ^l

Table 2-5. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-D-1A/116-D-1B

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7782-49-2	Selenium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^l	70-130 ^l
Performance Requirements for Physical Properties								
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937	N/A	N/A

Notes:

- Unless otherwise noted, Preliminary Cleanup Goals are established in the Washington Administrative Code (WAC) 173-340, "Model Toxics Control Act – Cleanup," 2007.
- Value includes a groundwater-to-river dilution attenuation factor of 2 based on the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE/RL-96-17, Rev. 6). A task is included in the *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* (DOE/RL-2008-46) to evaluate the appropriate dilution attenuation factor. Other considerations for analysis include WAC 173-340-730 (6)(b) (2007).
- Equivalent methods may be substituted. For EPA Method 300.0, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*. For EPA Method 200.8, see EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.
- Borehole will be logged with a neutron moisture tool and the high resolution, spectral gamma ray logging system. Geologic samples will also be logged. Vadose zone soil samples will be field-screened for gross alpha, gross beta, and gross gamma activities. Aquifer sediment samples will be field-screened for gross gamma activity.

Table 2-5. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-D-1A/116-D-1B

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
e.	Field measurements have no specific QC requirement for accuracy except to perform checks to verify manufacturer's expected performance.							
f.	Generic RESRAD modeling reported in DOE/RL-96-17, <i>Remedial Design Report/Remedial Action Work Plan for the 100 Area</i> , predicts the contaminant will not reach groundwater within 1,000 years; however, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.							
g.	Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.							
h.	The groundwater protection and river protection preliminary cleanup goal values for cesium-137, cobalt-60, neptunium-237, technetium-99, tritium, strontium-90, and nickel-63 were established in DOE/RL-96-17, <i>Remedial Design Report/Remedial Action Work Plan for the 100 Area</i> , Revision 6.							
i.	The Uranium-238 groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site Background.							
j.	Strontium-90 will be assessed as total radioactive strontium.							
k.	Calculated preliminary cleanup goals are less than established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.							
l.	Accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.							
m.	To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if estimated quantitation limits are met.							
n.	The preliminary cleanup goal value for arsenic will be re-evaluated as described in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i> .							
o.	Cobalt groundwater and river protection preliminary cleanup goal values are based on Hanford Site background values.							
p.	Manganese groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site background values.							
q.	A task is included in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i> to re-evaluate hexavalent chromium cleanup levels.							
r.	Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control limits, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Methods 8260 and 8270.							
s.	The uranium groundwater and river protection preliminary clean goal values are not risk-based. The values are based on Hanford Site background.							
ASTM D422-63, <i>Standard Test Method for Particle-Size Analysis of Soils</i> .								
ASTM D2216-05, <i>Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass</i> .								
ASTM D2434-68, <i>Standard Test Method for Permeability of Granular Soils (Constant Head)</i> .								

Table 2-5. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-D-1A/116-D-1B

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
ASTM D2937, <i>Standard Test Method for Density of Soil in Place by Drive-Cylinder Method.</i>								
ASTM D5084-03, <i>Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.</i>								
µg/L	=	micrograms per liter			mg/kg	=	milligrams per kilogram	
ASTM	=	American Society for Testing and Materials			MS	=	mass spectroscopy	
BHC	=	Benzenehexachloride			N/A	=	not applicable	
CAS No.	=	Chemical Abstracts Service number			NV	=	no value	
cm ²	=	square centimeters			PCB	=	polychlorinated biphenyl	
dpm	=	disintegrations per minute			pCi/g	=	picoCuries per gram	
EPA	=	U.S. Environmental Protection Agency			QC	=	quality control	
GC	=	gas chromatography			RESRAD	=	RESidual RADioactivity (dose model)	
IC	=	ion chromatography			TBD	=	to be determined	
ICP	=	inductively coupled plasma			UKPA	=	total uranium by kinetic phosphorescence analysis	
LSC	=	liquid scintillation counter						

Table 2-6. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-D-4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Field Measurements ^d								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	— ^e
12587-46-1	Gross alpha	100 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e

Table 2-6. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-D-4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
12587-47-2	Gross beta	5,000 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e
Performance Requirements for Laboratory Measurements (Radiological)								
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV ^f	NV ^f	LSC – Carbon-14	≤30 ^g	70-130 ^g
10028-17-8	Tritium ^h	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC – Tritium	≤30 ^g	70-130 ^g
13981-37-8	Nickel-63 ^h	30 pCi/g	4,026 pCi/g	83 pCi/g	166 pCi/g	LSC – Nickel-63	≤30 ^g	70-130 ^g
13967-70-9	Cesium-134	0.1 pCi/g	N/A	N/A	N/A	Gamma energy analysis	≤30 ^g	70-130 ^g
10045-97-3	Cesium-137 ^h	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g			
10198-40-0	Cobalt-60 ^h	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV ^f	NV ^f			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV ^f	NV ^f			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV ^f	NV ^f			
—	Uranium-233/234 ⁱ	1 pCi/g	1.1 pCi/g	NV ^f	NV ^f			
—	Uranium-238 ⁱ	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g	Isotopic – Uranium	≤30 ^g	70-130 ^g
13981-16-3	Plutonium-238	1 pCi/g	37.4 pCi/g	NV ^f	NV ^f	Isotopic – Plutonium	≤30 ^g	70-130 ^g
—	Plutonium-239/240	1 pCi/g	33.9 pCi/g	NV ^f	NV ^f			
10098-97-2	Strontium-90 ^{hj}	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30 ^g	70-130 ^g

Table 2-6. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-D-4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Laboratory Measurements (Nonradiological)								
16984-48-8	Fluoride	5 mg/kg	4,800 mg/kg	2,880 mg/kg	5,770 mg/kg	EPA 300.0 (Anions by IC)	≤30 ^k	70-130 ^k
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg			
14797-65-0	Nitrite (as N)	2.5 mg/kg	8,000 mg/kg	4 mg/kg	8 mg/kg			
14808-79-8	Sulfate	5 mg/kg	NV	1,030 mg/kg	2,060 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30 ^k	70-130 ^k
7440-36-0	Antimony	6 mg/kg ^l	32 mg/kg	5.4 mg/kg	25.3 mg/kg			
7440-38-2	Arsenic ^m	10 mg/kg	TBD	TBD	TBD			
7440-39-3	Barium	2 mg/kg	16,000 mg/kg	1,650 mg/kg	3,300 mg/kg			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-43-9	Cadmium	0.5 mg/kg ^l	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-48-4	Cobalt ⁿ	2 mg/kg	24 mg/kg	15.7 mg/kg	NV			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese ^o	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7440-22-4	Silver	1 mg/kg ^l	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-62-2	Vanadium	2.5 mg/kg	560 mg/kg	2,240 mg/kg	NV			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			

Table 2-6. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-D-4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
18540-29-9	Hexavalent chromium ^p	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Hexavalent chromium)	≤30 ^k	70-130 ^k
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 (mercury by cold vapor)	≤30 ^k	70-130 ^k
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg	EPA 8260 (volatile organic compounds)	≤30 ^q	70-130 ^q
75-35-4	1,1-Dichloroethene	0.01 mg/kg ^r	1.67 mg/kg	0.0005 mg/kg	0.0008 mg/kg	EPA 8270 (semivolatile organic compounds)	≤30 ^q	70-130 ^q
75-01-4	Vinyl Chloride	0.01 mg/kg ^r	0.667 mg/kg	0.00018 mg/kg	0.0252 mg/kg			
117-81-7	Bis(2-ethylhexyl) phthalate	0.33 mg/kg	71.4 mg/kg	13.9 mg/kg	8.01 mg/kg	EPA 8270 (semivolatile organic compounds)	≤30 ^q	70-130 ^q
84-74-2	di-n-Butyl phthalate	0.33 mg/kg	8,000 mg/kg	56.5 mg/kg	191 mg/kg			
7440-61-1	Uranium (total) ^s	1 mg/kg	240 mg/kg	3.21 mg/kg	3.21 mg/kg	UKPA or via isotopic	≤30 ^k	70-130 ^k
7440-38-2	Arsenic	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^k	70-130 ^k
7440-39-3	Barium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^k	70-130 ^k
7440-43-9	Cadmium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^k	70-130 ^k
7440-47-3	Chromium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^k	70-130 ^k

Table 2-6. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-D-4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
18540-29-9	Hexavalent chromium	3.7 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 7196	≤30 ^k	70-130 ^k
7439-92-1	Lead	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^k	70-130 ^k
7440-22-4	Silver	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^k	70-130 ^k
7782-49-2	Selenium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^k	70-130 ^k
Performance Requirements for Physical Properties								
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937	N/A	N/A

Table 2-6. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-D-4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			

Notes:

- a. Unless otherwise noted, Preliminary Cleanup Goals are established in Washington Administrative Code (WAC) 173-340, "Model Toxics Control Act – Cleanup," 2007.
- b. Value includes a groundwater-to-river dilution attenuation factor of 2 based on the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE/RL-96-17, Rev. 6). A task is included in the *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* (DOE/RL-2008-46) to evaluate the appropriate dilution attenuation factor. Other considerations for analysis include WAC 173-340-730 (6)(b) (2007).
- c. Equivalent methods may be substituted. For EPA Method 300.0, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*. For EPA Method 200.8, see EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.
- d. Soils will be logged with a neutron moisture tool and the high resolution, spectral gamma ray logging system. Geologic samples will also be logged. Vadose zone soil samples will be field-screened for gross alpha, gross beta, and gross gamma activities. Aquifer sediment samples will be field-screened for gross gamma activity.
- e. Field measurements have no specific QC requirement for accuracy except to perform checks to verify manufacturer's expected performance.
- f. Generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years; however, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.
- g. Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.
- h. The groundwater protection and river protection preliminary cleanup goal values for cesium-137, cobalt-60, tritium, strontium-90, and nickel-63 were established in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Revision 6.
- i. The Uranium-233/234 and Uranium-238 groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site Background.
- j. Strontium-90 will be assessed as total radioactive strontium.
- k. Accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.
- l. To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if estimated quantitation limits are met.
- m. The preliminary cleanup goal value for arsenic will be re-evaluated as described in DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan*.

Table 2-6. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-D-4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
n. Cobalt groundwater and river protection preliminary cleanup goal values are based on Hanford Site background values.								
o. Manganese groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site background values.								
p. A task is included in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i> to re-evaluate hexavalent chromium cleanup levels.								
q. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control limits, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Methods 8260 and 8270.								
r. Calculated preliminary cleanup goals are less than established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.								
s. The uranium groundwater and river protection preliminary clean goal values are not risk-based. The values are based on Hanford Site background.								
ASTM D422-63, <i>Standard Test Method for Particle-Size Analysis of Soils</i> .								
ASTM D2216-05, <i>Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass</i> .								
ASTM D2434-68, <i>Standard Test Method for Permeability of Granular Soils (Constant Head)</i> .								
ASTM D2937, <i>Standard Test Method for Density of Soil in Place by Drive-Cylinder Method</i> .								
ASTM D5084-03, <i>Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter</i> .								
µg/L	=	micrograms per liter			MS	=	mass spectroscopy	
ASTM	=	American Society for Testing and Materials			N/A	=	not applicable	
CAS No.	=	Chemical Abstracts Service number			NV	=	no value	
cm ²	=	square centimeters			pCi/g	=	picoCuries per gram	
dpm	=	disintegrations per minute			QC	=	quality control	
EPA	=	U.S. Environmental Protection Agency			RESRAD	=	RESidual RADioactivity (dose model)	
IC	=	ion chromatography			TBD	=	to be determined	
ICP	=	inductively coupled plasma			UKPA	=	total uranium by kinetic phosphorescence analysis	
LSC	=	liquid scintillation counter			WAC	=	<i>Washington Administrative Code</i>	
mg/kg	=	milligrams per kilogram						

Table 2-7. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-D-7

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Field Measurements ^d								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	— ^e
12587-46-1	Gross alpha	100 dpm/ 100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e
12587-47-2	Gross beta	5,000 dpm/ 100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e
Performance Requirements for Laboratory Measurements (Radiological)								
14596-10-2	Americium-241	1 pCi/g	31.1 pCi/g	NV ^f	NV ^f	Americium-241/ Curium-244	≤30 ^g	70-130 ^g
10045-97-3	Cesium-137 ^h	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	Gamma energy analysis	≤30 ^g	70-130 ^g
10198-40-0	Cobalt-60 ^h	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV ^f	NV ^f			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV ^f	NV ^f			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV ^f	NV ^f			
15117-96-1	Uranium-235 ⁱ	1 pCi/g ^j	0.61 pCi/g	0.185 pCi/g	0.185 pCi/g	Isotopic – Uranium	≤30 ^g	70-130 ^g
—	Uranium-238 ^k	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g	Strontium-90	≤30 ^g	70-130 ^g
10098-97-2	Strontium-90 ^{h,l}	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g			
13981-16-3	Plutonium-238	1 pCi/g	37.4 pCi/g	NV ^f	NV ^f			
—	Plutonium-239/ 240	1 pCi/g	33.9 pCi/g	NV ^f	NV ^f			
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV ^f	NV ^f			
13981-37-8	Nickel-63 ^h	30 pCi/g	4,026 pCi/g	83 pCi/g	166 pCi/g	LSC – Nickel-63	≤30 ^g	70-130 ^g

Table 2-7. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-D-7

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
14133-76-7	Technetium-99 ^h	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC – Technetium-99	≤30 ^g	70-130 ^g
10028-17-8	Tritium ^h	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC – Tritium	≤30 ^g	70-130 ^g
Performance Requirements for Laboratory Measurements (Nonradiological)								
16984-48-8	Fluoride	5 mg/kg	4,800 mg/kg	2,880 mg/kg	5,770 mg/kg	EPA 300.0 (Anions by IC)	≤30 ^m	70-130 ^m
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg			
14797-65-0	Nitrite (as N)	2.5 mg/kg	8,000 mg/kg	4 mg/kg	8 mg/kg			
14808-79-8	Sulfate	5 mg/kg	NV	1,030 mg/kg	2,060 mg/kg			
7440-36-0	Antimony	6 mg/kg ⁿ	32 mg/kg	5.4 mg/kg	25.3 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30 ^m	70-130 ^m
7440-38-2	Arsenic ^o	10 mg/kg	TBD	TBD	TBD			
7440-39-3	Barium	2 mg/kg	16,000 mg/kg	1,650 mg/kg	3,300 mg/kg			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-43-9	Cadmium	0.5 mg/kg ⁿ	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese ^p	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg ⁿ	400 mg/kg	5.2 mg/kg	1.04 mg/kg			

Table 2-7. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-D-7

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7440-22-4	Silver	1 mg/kg ⁿ	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg ⁿ	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-62-2	Vanadium	2.5 mg/kg	560 mg/kg	2,240 mg/kg	NV			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			
18540-29-9	Hexavalent chromium ^q	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Hexavalent chromium)	≤30 ^m	70-130 ^m
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 (mercury by cold vapor)	≤30 ^m	70-130 ^m
71-43-2	Benzene	0.005 mg/kg ^j	18.2 mg/kg	0.00448 mg/kg	0.014 mg/kg	EPA 8260 (volatile organic compounds)	≤30 ^r	70-130 ^r
56-23-5	Carbon tetrachloride	0.005mg/kg ^j	7.69 mg/kg	0.031 mg/kg	0.0046 mg/kg			
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
79-01-6	Trichloroethene	0.005 mg/kg ^j	11.2 mg/kg	0.00323 mg/kg	0.0355 mg/kg			
117-81-7	Bis(2-ethylhexyl) phthalate	0.33 mg/kg	71.4 mg/kg	13.9 mg/kg	8.01 mg/kg	EPA 8270 (semivolatile organic compounds)	≤30 ^r	70-130 ^r
108-95-2	Phenol	0.33 mg/kg	24,000 mg/kg	11 mg/kg	192 mg/kg			
7440-61-1	Uranium (total) ^s	1 mg/kg	240 mg/kg	3.21 mg/kg	3.21 mg/kg	UKPA or via isotopic	≤30 ^m	70-130 ^m
7440-38-2	Arsenic	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m

Table 2-7. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-D-7

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7440-39-3	Barium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-43-9	Cadmium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-47-3	Chromium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
18540-29-9	Hexavalent chromium	3.7 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 7196	≤30 ^m	70-130 ^m
7439-92-1	Lead	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-22-4	Silver	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7782-49-2	Selenium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
Performance Requirements for Physical Properties								
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216	N/A	N/A

Table 2-7. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-D-7

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937	N/A	N/A

Notes:

- Unless otherwise noted, Preliminary Cleanup Goals are established in WAC 173-340, "Model Toxics Control Act – Cleanup," 2007.
- Value includes a groundwater-to-river dilution attenuation factor of 2 based on the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE/RL-96-17, Rev. 6). A task is included in the *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* (DOE/RL-2008-46) to evaluate the appropriate dilution attenuation factor. Other considerations for analysis include WAC 173-340-730 (6)(b) (2007).
- Equivalent methods may be substituted. For EPA Method 300.0, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*. For EPA Method 200.8, see EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.
- Borehole will be logged with a neutron moisture tool and the high resolution, spectral gamma ray logging system. Geologic samples will also be logged. Vadose zone soil samples will be field-screened for gross alpha, gross beta, and gross gamma activities. Aquifer sediment samples will be field-screened for gross gamma activity.
- Field measurements have no specific QC requirement for accuracy except to perform checks to verify manufacturer's expected performance.
- Generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years; however, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.
- Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.
- The groundwater protection and river protection preliminary cleanup goal values for cesium-137, cobalt-60, technetium-99, tritium, strontium-90, and nickel-63 were established in DOE/RL-6-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Revision 6.
- The Uranium-235 groundwater and river protection preliminary cleanup goal values are based on the recommended daily limit.
- Calculated cleanup goals are less than established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.

Table 2-7. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-D-7

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
<p>k. The Uranium-238 groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site Background.</p> <p>l. Strontium-90 will be assessed as total radioactive strontium.</p> <p>m. Accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.</p> <p>n. To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if estimated quantitation limits are met.</p> <p>o. The preliminary cleanup goal value for arsenic will be re-evaluated as described in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i>.</p> <p>p. Manganese groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site background values.</p> <p>q. A task is included in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i> to re-evaluate hexavalent chromium cleanup levels.</p> <p>r. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control limits, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Methods 8260 and 8270.</p> <p>s. The uranium groundwater and river protection preliminary clean goal values are not risk-based. The values are based on Hanford Site background.</p> <p>ASTM D422-63, <i>Standard Test Method for Particle-Size Analysis of Soils</i>.</p> <p>ASTM D2216-05, <i>Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass</i>.</p> <p>ASTM D2434-68, <i>Standard Test Method for Permeability of Granular Soils (Constant Head)</i>.</p> <p>ASTM D2937, <i>Standard Test Method for Density of Soil in Place by Drive-Cylinder Method</i>.</p> <p>ASTM D5084-03, <i>Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter</i>.</p>								

Table 2-7. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-D-7

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
µg/L	= micrograms per liter				MS	= mass spectroscopy		
ASTM	= American Society for Testing and Materials				N/A	= not applicable		
CAS No.	= Chemical Abstracts Service number				NV	= no value		
cm ²	= square centimeters				pCi/g	= picoCuries per gram		
dpm	= disintegrations per minute				QC	= quality control		
EPA	= U.S. Environmental Protection Agency				RESRAD	= RESidual RADioactivity (dose model)		
IC	= ion chromatography				TBD	= to be determined		
ICP	= inductively coupled plasma				UKPA	= total uranium by kinetic phosphorescence analysis		
LSC	= liquid scintillation counter				WAC	= <i>Washington Administrative Code</i>		
mg/kg	= milligrams per kilogram							

Table 2-8. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-DR-1&2

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Field Measurements ^d								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	— ^e
12587-46-1	Gross alpha	100 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e
12587-47-2	Gross beta	5,000 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e

Table 2-8. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-DR-1&2

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Laboratory Measurements (Radiological)								
14596-10-2	Americium-241	1 pCi/g	31.1 pCi/g	NV ^f	NV ^f	Americium-241/ Curium-244	≤30 ^g	70-130 ^g
10045-97-3	Cesium-137 ^h	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	Gamma energy analysis	≤30 ^g	70-130 ^g
10198-40-0	Cobalt-60 ^h	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV ^f	NV ^f			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV ^f	NV ^f			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV ^f	NV ^f			
15117-96-1	Uranium-235 ⁱ	0.5 pCi/g ^j	0.61 pCi/g	0.185 pCi/g	0.185 pCi/g	Isotopic – Uranium	≤30 ^g	70-130 ^g
—	Uranium-238 ^k	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g			
10098-97-2	Strontium-90 ^{h,l}	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30 ^g	70-130 ^g
13981-16-3	Plutonium-238	1 pCi/g	37.4 pCi/g	NV ^f	NV ^f	Isotopic – Plutonium	≤30 ^g	70-130 ^g
—	Plutonium-239/240	1 pCi/g	33.9 pCi/g	NV ^f	NV ^f			
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV ^f	NV ^f	LSC – Carbon-14	≤30 ^g	70-130 ^g
13981-37-8	Nickel-63 ^h	30 pCi/g	4,026 pCi/g	83 pCi/g	166 pCi/g	LSC – Nickel-63	≤30 ^g	70-130 ^g
14133-76-7	Technetium-99 ^h	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC – Technetium-99	≤30 ^g	70-130 ^g
10028-17-8	Tritium ^h	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC – Tritium	≤30 ^g	70-130 ^g
Performance Requirements for Laboratory Measurements (Nonradiological)								
16984-48-8	Fluoride	5 mg/kg	4,800 mg/kg	2,880 mg/kg	5,770 mg/kg	EPA 300.0 (Anions by IC)	≤30 ^m	70-130 ^m
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg			
14797-65-0	Nitrite (as N)	2.5 mg/kg	8,000 mg/kg	4 mg/kg	8 mg/kg			
14808-79-8	Sulfate	5 mg/kg	NV	1,030 mg/kg	2,060 mg/kg			

Table 2-8. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-DR-1&2

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7440-39-3	Barium	2 mg/kg	16,000 mg/kg	1,650 mg/kg	3,300 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30 ^m	70-130 ^m
7440-43-9	Cadmium	0.5 mg/kg ⁿ	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese ^o	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7440-22-4	Silver	1 mg/kg ⁿ	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg ⁿ	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-62-2	Vanadium	2.5 mg/kg	560 mg/kg	2,240 mg/kg	NV			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg	EPA 7196 (Hexavalent chromium)	≤30 ^m	70-130 ^m
18540-29-9	Hexavalent chromium ^p	0.5 mg/kg	TBD	TBD	TBD			
75-35-4	1,1-Dichloroethene	0.01 mg/kg ^j	1.67 mg/kg	0.0005 mg/kg	0.0008 mg/kg	EPA 8260 (volatile organic compounds)	≤30 ^q	70-130 ^q
67-64-1	Acetone	0.02 mg/kg	72,000 mg/kg	28.9 mg/kg	NV			
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
75-09-2	Methylene chloride	0.005 mg/kg	133 mg/kg	0.218 mg/kg	0.0409 mg/kg			
108-88-3	Toluene	0.005 mg/kg	6,400 mg/kg	4.65 mg/kg	99 mg/kg			
75-01-4	Vinyl Chloride	0.01 mg/kg ^j	0.667 mg/kg	0.00018 mg/kg	0.0252 mg/kg			

Table 2-8. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-DR-1&2

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
541-43-1	1,3-Dichlorobenzene	0.33 mg/kg	2,400 mg/kg	3.09 mg/kg	10.3 mg/kg	EPA 8270 (semivolatile organic compounds)	≤30 ^q	70-130 ^q
106-46-7	1,4-Dichlorobenzene	0.33 mg/kg	41.7 mg/kg	0.030 mg/kg	0.160 mg/kg			
95-57-8	2-Chlorophenol	0.33 mg/kg	400 mg/kg	0.422 mg/kg	2.28 mg/kg			
59-50-7	4-Chloro-3-methylphenol ^r	0.33 mg/kg	4,000 mg/kg	5.07 mg/kg	10.1 mg/kg			
84-74-2	di-n-Butyl phthalate	0.33 mg/kg	8,000 mg/kg	56.5 mg/kg	191 mg/kg			
7440-61-1	Uranium (total) ^s	1 mg/kg	240 mg/kg	3.21 mg/kg	3.21 mg/kg	UKPA or via isotopic	≤30 ^m	70-130 ^m
7440-38-2	Arsenic	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-39-3	Barium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-43-9	Cadmium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-47-3	Chromium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
18540-29-9	Hexavalent chromium	3.7 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 7196	≤30 ^m	70-130 ^m
7439-92-1	Lead	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-22-4	Silver	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7782-49-2	Selenium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m

Table 2-8. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-DR-1&2

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Physical Properties								
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937	N/A	N/A

Notes:

- Unless otherwise noted, Preliminary Cleanup Goals are established in the WAC 173-340, "Model Toxics Control Act – Cleanup," 2007.
- Value includes a groundwater-to-river dilution attenuation factor of 2 based on the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE/RL-96-17, Rev. 6). A task is included in the *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* (DOE/RL-2008-46) to evaluate the appropriate dilution attenuation factor. Other considerations for analysis include WAC 173-340-730 (6)(b) (2007).
- Equivalent methods may be substituted. For EPA Method 300.0, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*. For EPA Method 200.8, see EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.
- Borehole will be logged with a neutron moisture tool and the high resolution, spectral gamma ray logging system. Geologic samples will also be logged. Vadose zone soil samples will be field-screened for gross alpha, gross beta, and gross gamma activities. Aquifer sediment samples will be field-screened for gross gamma activity.
- Field measurements have no specific QC requirement for accuracy except to perform checks to verify manufacturer's expected performance.
- Generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years; however, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.

Table 2-8. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-DR-1&2

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			

- g. Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.
- h. The groundwater protection and river protection preliminary cleanup goal values for cesium-137, cobalt-60, technetium-99, tritium, strontium-90, and nickel-63 were established in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Revision 6.
- i. The Uranium-235 groundwater and river protection preliminary cleanup goal values are based on the recommended daily limit.
- j. Calculated preliminary cleanup goals are less than established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.
- k. The Uranium-238 groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site Background.
- l. Strontium-90 will be assessed as total radioactive strontium.
- m. Accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.
- n. To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if estimated quantitation limits are met.
- o. Manganese groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site background values.
- p. A task is included in DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* to re-evaluate hexavalent chromium cleanup levels.
- q. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control limits, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Methods 8260 and 8270.
- r. The preliminary cleanup goal values listed for 4-chloro-3-methylphenol are the MTCA 2007 values for 3-methylphenol (WAC 173-340). 3-Methylphenol was used as a surrogate to provide the toxicity values for 4-chloro-3-methylphenol.
- s. The uranium groundwater and river protection preliminary clean goal values are not risk-based. The values are based on Hanford Site background.

ASTM D422-63, *Standard Test Method for Particle-Size Analysis of Soils*.

ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*.

ASTM D2434-68, *Standard Test Method for Permeability of Granular Soils (Constant Head)*.

ASTM D2937, *Standard Test Method for Density of Soil in Place by Drive-Cylinder Method*.

ASTM D5084-03, *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*.

Table 2-8. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-DR-1&2

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
µg/L	=	micrograms per liter			MS	=	mass spectroscopy	
ASTM	=	American Society for Testing and Materials			MTCA	=	model toxics control act	
CAS No.	=	Chemical Abstracts Service number			N/A	=	not applicable	
cm ²	=	square centimeters			NV	=	no value	
dpm	=	disintegrations per minute			pCi/g	=	picoCuries per gram	
EPA	=	U.S. Environmental Protection Agency			QC	=	quality control	
IC	=	ion chromatography			RESRAD	=	RESidual RADioactivity (dose model)	
ICP	=	inductively coupled plasma			TBD	=	to be determined	
LSC	=	liquid scintillation counter			UKPA	=	total uranium by kinetic phosphorescence analysis	
mg/kg	=	milligrams per kilogram			WAC	=	<i>Washington Administrative Code</i>	

Table 2-9. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-DR-9

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Field Measurements ^d								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	— ^e
12587-46-1	Gross alpha	100 dpm/ 100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e
12587-47-2	Gross beta	5,000 dpm/ 100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e

Table 2-9. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-DR-9

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Laboratory Measurements (Radiological)								
14596-10-2	Americium-241	1 pCi/g	31.1 pCi/g	NV ^f	NV ^f	Americium-241/ Curium-244	≤30 ^g	70-130 ^g
10045-97-3	Cesium-137 ^h	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	Gamma energy analysis	≤30 ^g	70-130 ^g
10198-40-0	Cobalt-60 ^h	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV ^f	NV ^f			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV ^f	NV ^f			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV ^f	NV ^f			
—	Uranium-238 ⁱ	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g	Isotopic – Uranium	≤30 ^g	70-130 ^g
10098-97-2	Strontium-90 ^{h,j}	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30 ^g	70-130 ^g
13981-16-3	Plutonium-238	1 pCi/g	37.4 pCi/g	NV ^f	NV ^f	Isotopic – Plutonium	≤30 ^g	70-130 ^g
—	Plutonium-239/240	1 pCi/g	33.9 pCi/g	NV ^f	NV ^f			
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV ^f	NV ^f	LSC – Carbon-14	≤30 ^g	70-130 ^g
13981-37-8	Nickel-63 ^h	30 pCi/g	4,026 pCi/g	83 pCi/g	166 pCi/g	LSC – Nickel-63	≤30 ^g	70-130 ^g
14133-76-7	Technetium-99 ^h	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC – Technetium-99	≤30 ^g	70-130 ^g
10028-17-8	Tritium ^h	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC – Tritium	≤30 ^g	70-130 ^g

Table 2-9. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-DR-9

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Laboratory Measurements (Nonradiological)								
16984-48-8	Fluoride	5 mg/kg	4,800 mg/kg	2,880 mg/kg	5,770 mg/kg	EPA 300.0 (Anions by IC)	≤30 ^k	70-130 ^k
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg			
14797-65-0	Nitrite (as N)	2.5 mg/kg	8,000 mg/kg	4 mg/kg	8 mg/kg			
14808-79-8	Sulfate	5 mg/kg	NV	1,030 mg/kg	2,060 mg/kg			
7440-36-0	Antimony	6 mg/kg ^l	32 mg/kg	5.4 mg/kg	25.3 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30 ^k	70-130 ^k
7440-38-2	Arsenic ^m	10 mg/kg	TBD	TBD	TBD			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-39-3	Barium	2 mg/kg	16,000 mg/kg	1,650 mg/kg	3,300 mg/kg			
7440-43-9	Cadmium	0.5 mg/kg ^l	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese ⁿ	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			

Table 2-9. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-DR-9

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7782-49-2	Selenium	10 mg/kg ^l	400 mg/kg	5.2 mg/kg	1.04 mg/kg			
7440-22-4	Silver	1 mg/kg ^l	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg ^l	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-62-2	Vanadium	2.5 mg/kg	560 mg/kg	2,240 mg/kg	NV			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 (mercury by cold vapor)	≤30 ^k	70-130 ^k
18540-29-9	Hexavalent chromium ^o	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Hexavalent chromium)	≤30 ^k	70-130 ^k
53469-21-9	Aroclor-1242 (PCB)	0.017 mg/kg ^p	0.5 mg/kg	0.0394 mg/kg	0.000187 mg/kg	EPA 8082 (PCB by GC)	≤30 ^q	70-130 ^q
11097-69-1	Aroclor-1254 (PCB)	0.017 mg/kg ^p	0.5 mg/kg	0.0664 mg/kg	0.000315 mg/kg			
11096-82-5	Aroclor-1260 (PCB)	0.017 mg/kg ^p	0.5 mg/kg	0.721 mg/kg	0.00342 mg/kg			
75-35-4	1,1-Dichloroethene	0.01 mg/kg ^p	1.67 mg/kg	0.0005 mg/kg	0.0008 mg/kg	EPA 8260 (volatile organic compounds)	≤30 ^q	70-130 ^q
67-64-1	Acetone	0.02 mg/kg	72,000 mg/kg	28.9 mg/kg	NV			
71-43-2	Benzene	0.005 mg/kg ^p	18.2 mg/kg	0.00448 mg/kg	0.014 mg/kg			
56-23-5	Carbon tetrachloride	0.005 mg/kg ^p	7.69 mg/kg	0.031 mg/kg	0.0046 mg/kg			
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
75-09-2	Methylene chloride	0.005 mg/kg	133 mg/kg	0.218 mg/kg	0.0409 mg/kg			

Table 2-9. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-DR-9

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
108-88-3	Toluene	0.005 mg/kg	6,400 mg/kg	4.65 mg/kg	99 mg/kg			
79-01-6	Trichloroethene	0.005 mg/kg ^p	11.2 mg/kg	0.00323 mg/kg	0.0355 mg/kg			
75-01-4	Vinyl chloride	0.01 mg/kg ^p	0.667 mg/kg	0.00018 mg/kg	0.0252 mg/kg			
88-75-5	2-Nitrophenol	0.66 mg/kg	NV	NV	NV	EPA 8270 (semivolatile organic compounds)	≤30 ^q	70-130 ^q
65-85-0	Benzoic acid	16.5 mg/kg	320,000 mg/kg	257 mg/kg	NV			
117-81-7	Bis(2-ethylhexyl) phthalate	0.33 mg/kg	71.4 mg/kg	13.9 mg/kg	8.01 mg/kg			
85-68-7	Butylbenzyl phthalate	0.33 mg/kg	16,000 mg/kg	893 mg/kg	698 mg/kg			
84-66-2	Diethyl phthalate	0.33 mg/kg	71.4 mg/kg	13.9 mg/kg	8.01 mg/kg			
84-74-2	Di-n-butyl phthalate	0.33 mg/kg	8,000 mg/kg	56.5 mg/kg	191 mg/kg			
87-86-5	Pentachlorophenol	0.33 mg/kg ^p	8.33 mg/kg	0.0158 mg/kg	0.00887 mg/kg			
120-12-7	Anthracene	0.015 mg/kg	24,000 mg/kg	1,140 mg/kg	9,100 mg/kg	EPA 8310 (polynuclear aromatic hydrocarbons)	≤30 ^q	70-130 ^q
56-55-3	Benzo(a) anthracene	0.015 mg/kg	1.37 mg/kg	0.856 mg/kg	0.04 mg/kg			
50-32-8	Benzo(a)pyrene	0.015 mg/kg	0.137 mg/kg	2.33 mg/kg	0.109 mg/kg			

Table 2-9. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-DR-9

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
205-99-2	Benzo(b) fluoranthene	0.015 mg/kg	1.37 mg/kg	2.95 mg/kg	0.138 mg/kg			
191-24-2	Benzo(ghi) perylene	0.03 mg/kg	2,400 mg/kg	25,700 mg/kg	7,070 mg/kg			
207-08-9	Benzo(k) fluoranthene	0.015 mg/kg	1.37 mg/kg	21.5 mg/kg	0.138 mg/kg			
218-01-9	Chrysene	0.1 mg/kg ^p	13.7 mg/kg	9.56 mg/kg	0.0446 mg/kg			
206-44-0	Fluoranthene	0.05 mg/kg	3,200 mg/kg	631 mg/kg	178 mg/kg			
193-39-5	Indeno(1,2,3-cd) pyrene	0.03 mg/kg	1.37 mg/kg	8.33 mg/kg	0.389 mg/kg			
129-00-0	Pyrene	0.05 mg/kg	2,400 mg/kg	655 mg/kg	2,620 mg/kg			
7440-61-1	Uranium (total) ^f	1 mg/kg	240 mg/kg	3.21 mg/kg	3.21 mg/kg	UKPA or via isotopic	≤30 ^k	70-130 ^k
7440-38-2	Arsenic	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^k	70-130 ^k
7440-39-3	Barium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^k	70-130 ^k
7440-43-9	Cadmium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^k	70-130 ^k
7440-47-3	Chromium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^k	70-130 ^k

Table 2-9. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-DR-9

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
18540-29-9	Hexavalent chromium	3.7 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 7196	≤30 ^k	70-130 ^k
7439-92-1	Lead	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^k	70-130 ^k
7440-22-4	Silver	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^k	70-130 ^k
7782-49-2	Selenium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^k	70-130 ^k
Performance Requirements for Physical Properties								
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937	N/A	N/A

Notes:

a. Unless otherwise noted, Preliminary Cleanup Goals are established in WAC 173-340“Model Toxics Control Act – Cleanup,” 2007.

Table 2-9. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-DR-9

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
<p>b. Value includes a groundwater-to-river dilution attenuation factor of 2 based on the <i>Remedial Design Report/Remedial Action Work Plan for the 100 Area</i> (DOE/RL-96-17, Rev. 6). A task is included in the <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i> (DOE/RL-2008-46) to evaluate the appropriate dilution attenuation factor. Other considerations for analysis include WAC 173-340-730 (6)(b) (2007).</p> <p>c. Equivalent methods may be substituted. For EPA Method 300.0, see EPA-600/4-79-020, <i>Methods for Chemical Analysis of Water and Wastes</i>. For EPA Method 200.8, see EPA-600/R-94-111, <i>Methods for the Determination of Metals in Environmental Samples, Supplement 1</i>. For the four-digit EPA methods, see SW-846, <i>Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B</i>.</p> <p>d. Borehole will be logged with a neutron moisture tool and the high resolution, spectral gamma ray logging system. Geologic samples will also be logged. Vadose zone soil samples will be field-screened for gross alpha, gross beta, and gross gamma activities. Aquifer sediment samples will be field-screened for gross gamma activity.</p> <p>e. Field measurements have no specific QC requirement for accuracy except to perform checks to verify manufacturer's expected performance.</p> <p>f. Generic RESRAD modeling reported in DOE/RL-96-17, <i>Remedial Design Report/Remedial Action Work Plan for the 100 Area</i>, predicts the contaminant will not reach groundwater within 1,000 years; however, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.</p> <p>g. Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.</p> <p>h. The groundwater protection and river protection preliminary cleanup goal values for cesium-137, cobalt-60, technetium-99, tritium, strontium-90, and nickel-63 were established in DOE/RL-96-17, <i>Remedial Design Report/Remedial Action Work Plan for the 100 Area</i>, Revision 6.</p> <p>i. The Uranium-238 groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site Background.</p> <p>j. Strontium-90 will be assessed as total radioactive strontium.</p> <p>k. Accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.</p> <p>l. To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if estimated quantitation limits are met.</p> <p>m. The preliminary cleanup goal value for arsenic will be re-evaluated as described in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i>.</p> <p>n. The manganese groundwater and river protection preliminary cleanup goal values are not risk based. They are based on Hanford site background.</p> <p>o. A task is included in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i> to re-evaluate hexavalent chromium cleanup levels.</p>								

Table 2-9. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-DR-9

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			

p. Calculated preliminary cleanup goals are less than established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.

q. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control limits, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Methods 8260 and 8270.

r. The uranium groundwater and river protection preliminary clean goal values are not risk-based. The values are based on Hanford Site background.

ASTM D422-63, *Standard Test Method for Particle-Size Analysis of Soils*.

ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*.

ASTM D2434-68, *Standard Test Method for Permeability of Granular Soils (Constant Head)*.

ASTM D2937, *Standard Test Method for Density of Soil in Place by Drive-Cylinder Method*.

ASTM D5084-03, 2003, *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*.

µg/L = micrograms per liter

MS = mass spectroscopy

ASTM = American Society for Testing and Materials

N/A = not applicable

cm² = square centimeters

NV = no value

CAS No. = Chemical Abstracts Service number

PCB = polychlorinated biphenyl

dpm = disintegrations per minute

pCi/g = picoCuries per gram

EPA = U.S. Environmental Protection Agency

QC = quality control

GC = gas chromatography

RESRAD = RESidual RADioactivity (dose model)

IC = ion chromatography

TBD = to be determined

ICP = inductively coupled plasma

UKPA = total uranium by kinetic phosphorescence analysis

LSC = liquid scintillation counter

WAC = *Washington Administrative Code*

mg/kg = milligrams per kilogram

Table 2-10. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-D-6

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Field Measurements ^d								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	— ^e
12587-46-1	Gross alpha	100 dpm/ 100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e
12587-47-2	Gross beta	5,000 dpm/ 100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e
Performance Requirements for Laboratory Measurements (Radiological)								
14596-10-2	Americium-241	1 pCi/g	31.1 pCi/g	NV ^f	NV ^f	Americium-241/ Curium-244	≤30 ^g	70-130 ^g
10045-97-3	Cesium-137 ^h	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	Gamma energy analysis	≤30 ^g	70-130 ^g
10198-40-0	Cobalt-60 ^h	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV ^f	NV ^f			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV ^f	NV ^f			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV ^f	NV ^f			
—	Uranium-233/234 ⁱ	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g	Isotopic – Uranium	≤30 ^g	70-130 ^g
15117-96-1	Uranium-235 ^j	1 pCi/g ^k	0.61 pCi/g	0.185 pCi/g	0.185 pCi/g			
—	Uranium-238 ⁱ	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g			
10098-97-2	Strontium-90 ^{h,l}	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30 ^g	70-130 ^g
13981-16-3	Plutonium-238	1 pCi/g	37.4 pCi/g	NV ^f	NV ^f	Isotopic – Plutonium	≤30 ^g	70-130 ^g
—	Plutonium-239/240	1 pCi/g	33.9 pCi/g	NV ^f	NV ^f			
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV ^f	NV ^f	LSC – Carbon-14	≤30 ^g	70-130 ^g
13981-37-8	Nickel-63 ^h	30 pCi/g	4,026 pCi/g	83 pCi/g	166 pCi/g	LSC – Nickel-63	≤30 ^g	70-130 ^g

Table 2-10. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-D-6

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
14133-76-7	Technetium-99 ^h	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC – Technetium-99	≤30 ^g	70-130 ^g
10028-17-8	Tritium ^h	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC – Tritium	≤30 ^g	70-130 ^g
13994-20-2	Neptunium-237 ^h	1 pCi/g ^k	2.44 pCi/g	0.9 pCi/g	1.80 pCi/g	Atomic energy absorption	≤30 ^g	70-130 ^g
Performance Requirements for Laboratory Measurements (Nonradiological)								
16984-48-8	Fluoride	5 mg/kg	4,800 mg/kg	2,880 mg/kg	5,770 mg/kg	EPA 300.0 (Anions by IC)	≤30 ^m	70-130 ^m
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg			
14808-79-8	Sulfate	5 mg/kg	NV	1,030 mg/kg	2,060 mg/kg			
7440-38-2	Arsenic ⁿ	10 mg/kg	TBD	TBD	TBD	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30 ^m	70-130 ^m
7440-39-3	Barium	2 mg/kg	16,000 mg/kg	1,650 mg/kg	3,300 mg/kg			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-48-4	Cobalt ^o	2 mg/kg	24 mg/kg	15.7 mg/kg	NV			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese ^p	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg ^q	400 mg/kg	5.2 mg/kg	1.04 mg/kg			

Table 2-10. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-D-6

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7440-22-4	Silver	1 mg/kg ^q	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg ^q	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-62-2	Vanadium	2.5 mg/kg	560 mg/kg	2,240 mg/kg	NV			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			
18540-29-9	Hexavalent chromium ^r	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Hexavalent chromium)	≤30 ^m	70-130 ^m
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 (mercury by cold vapor)	≤30 ^m	70-130 ^m
11097-69-1	Aroclor-1254 (PCB)	0.017 mg/kg ^k	0.5 mg/kg	0.0664 mg/kg	0.000315 mg/kg	EPA 8082 (PCBs by GC)	≤30 ^s	70-130 ^s
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg	EPA 8260 (volatile organic compounds)	≤30 ^s	70-130 ^s
75-35-4	1,1-Dichloroethene	0.01 mg/kg ^k	1.67 mg/kg	0.0005 mg/kg	0.0008 mg/kg			
75-01-4	Vinyl Chloride	0.01 mg/kg ^k	0.667 mg/kg	0.00018 mg/kg	0.0252 mg/kg			
7440-61-1	Uranium (total) ^t	1 mg/kg	240 mg/kg	3.21 mg/kg	3.21 mg/kg	UKPA or via isotopic	≤30 ^m	70-130 ^m
7440-38-2	Arsenic	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-39-3	Barium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-43-9	Cadmium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m

Table 2-10. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-D-6

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7440-47-3	Chromium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
18540-29-9	Hexavalent chromium	3.7 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 7196	≤30 ^m	70-130 ^m
7439-92-1	Lead	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-22-4	Silver	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7782-49-2	Selenium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
Performance Requirements for Physical Properties								
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937	N/A	N/A

Table 2-10. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-D-6

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			

Notes:

- a. Unless otherwise noted, Preliminary Cleanup Goals are established in WAC 173-340, "Model Toxics Control Act – Cleanup," 2007.
- b. Value includes a groundwater-to-river dilution attenuation factor of 2 based on the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE/RL-96-17, Rev. 6). A task is included in the *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* (DOE/RL-2008-46) to evaluate the appropriate dilution attenuation factor. Other considerations for analysis include WAC 173-340-730 (6)(b) (2007).
- c. Equivalent methods may be substituted. For EPA Method 300.0, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*. For EPA Method 200.8, see EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.
- d. Borehole will be logged with a neutron moisture tool and the high resolution, spectral gamma ray logging system. Geologic samples will also be logged. Vadose zone soil samples will be field-screened for gross alpha, gross beta, and gross gamma activities. Aquifer sediment samples will be field-screened for gross gamma activity.
- e. Field measurements have no specific QC requirement for accuracy except to perform checks to verify manufacturer's expected performance.
- f. Generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years; however, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.
- g. Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.
- h. The groundwater protection and river protection preliminary cleanup goal values for cesium-137, cobalt-60, neptunium-237, technetium-99, tritium, strontium-90, and nickel-63 were established in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Revision 6.
- i. The Uranium-233/234 and Uranium-238 groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site Background.
- j. The Uranium-235 groundwater and river protection preliminary cleanup goal values are based on the recommended daily limit.
- k. Calculated preliminary cleanup goals are less than established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.
- l. Strontium-90 will be assessed as total radioactive strontium.
- m. Accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.
- n. The preliminary cleanup goal value for arsenic will be re-evaluated as described in DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan*.
- o. Cobalt groundwater and river protection preliminary cleanup goal values are based on Hanford Site background values.

Table 2-10. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-D-6

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
p. Manganese groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site background values.								
q. To meet or approach calculated cleanup goals, laboratories must use axial-based (“trace”) ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if estimated quantitation limits are met.								
r. A task is included in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i> to re-evaluate hexavalent chromium cleanup levels.								
s. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control limits, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Method 8260.								
t. The uranium groundwater and river protection preliminary clean goal values are not risk-based. The values are based on Hanford Site background.								
ASTM D422-63, <i>Standard Test Method for Particle-Size Analysis of Soils</i> .								
ASTM D2216-05, <i>Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass</i> .								
ASTM D2434-68, <i>Standard Test Method for Permeability of Granular Soils (Constant Head)</i> .								
ASTM D2937, <i>Standard Test Method for Density of Soil in Place by Drive-Cylinder Method</i> .								
ASTM D5084-03, <i>Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter</i> .								
µg/L	=	micrograms per liter			MS	=	mass spectroscopy	
ASTM	=	American Society for Testing and Materials			N/A	=	not applicable	
cm ²	=	square centimeters			NV	=	no value	
CAS No.	=	Chemical Abstracts Service number			PCB	=	polychlorinated biphenyl	
dpm	=	disintegrations per minute			pCi/g	=	picoCuries per gram	
EPA	=	U.S. Environmental Protection Agency			QC	=	quality control	
GC	=	gas chromatography			RESRAD	=	RESidual RADioactivity (dose model)	
IC	=	ion chromatography			TBD	=	to be determined	
ICP	=	inductively coupled plasma			UKPA	=	total uranium by kinetic phosphorescence analysis	
LSC	=	liquid scintillation counter			WAC	=	<i>Washington Administrative Code</i>	
mg/kg	=	milligrams per kilogram						

Table 2-11. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-1

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Field Measurements ^d								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	— ^e
12587-46-1	Gross alpha	100 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e
12587-47-2	Gross beta	5,000 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e
Performance Requirements for Laboratory Measurements (Radiological)								
14596-10-2	Americium-241	1 pCi/g	31.1 pCi/g	NV ^f	NV ^f	Americium-241/ Curium-244	≤30 ^g	70-130 ^g
10045-97-3	Cesium-137 ^h	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	Gamma energy analysis	≤30 ^g	70-130 ^g
10198-40-0	Cobalt-60 ^h	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV ^f	NV ^f			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV ^f	NV ^f			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV ^f	NV ^f			
—	Uranium-233/234 ⁱ	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g	Isotopic – Uranium	≤30 ^g	70-130 ^g
15117-96-1	Uranium-235 ^j	0.5 pCi/g ^k	0.61 pCi/g	0.185 pCi/g	0.185 pCi/g			
—	Uranium-238 ⁱ	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g			
10098-97-2	Strontium-90 ^{h,i}	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30 ^g	70-130 ^g
—	Plutonium-239/240	1 pCi/g	33.9 pCi/g	NV ^f	NV ^f	Isotopic – Plutonium	≤30 ^g	70-130 ^g
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV ^f	NV ^f	LSC – Carbon-14	≤30 ^g	70-130 ^g

Table 2-11. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-1

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
14133-76-7	Technetium-99 ^h	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC – Technetium-99	≤30 ^g	70-130 ^g
10028-17-8	Tritium ^h	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC – Tritium	≤30 ^g	70-130 ^g
Performance Requirements for Laboratory Measurements (Nonradiological)								
16984-48-8	Fluoride	5 mg/kg	4,800 mg/kg	2,880 mg/kg	5,770 mg/kg	EPA 300.0 (Anions by IC)	≤30 ^m	70-130 ^m
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg			
14797-65-0	Nitrite (as N)	2.5 mg/kg	8,000 mg/kg	4 mg/kg	8 mg/kg			
14808-79-8	Sulfate	5 mg/kg	NV	1,030 mg/kg	2,060 mg/kg			
7440-36-0	Antimony	6 mg/kg ⁿ	32 mg/kg	5.4 mg/kg	25.3 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30 ^m	70-130 ^m
7440-38-2	Arsenic ^o	10 mg/kg	TBD	TBD	TBD			
7440-39-3	Barium	2 mg/kg	16,000 mg/kg	1,650 mg/kg	3,300 mg/kg			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-43-9	Cadmium	0.5 mg/kg ⁿ	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese ^p	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg ⁿ	400 mg/kg	5.2 mg/kg	1.04 mg/kg			
7440-22-4	Silver	1 mg/kg ⁿ	400 mg/kg	13.6 mg/kg	0.884 mg/kg			

Table 2-11. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-1

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7440-28-0	Thallium	5 mg/kg ⁿ	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-62-2	Vanadium	2.5 mg/kg	560 mg/kg	2,240 mg/kg	NV			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			
18540-29-9	Hexavalent chromium ^q	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Hexavalent chromium)	≤30 ^m	70-130 ^m
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 (mercury by cold vapor)	≤30 ^m	70-130 ^m
67-64-1	Acetone	0.02 mg/kg	72,000 mg/kg	28.9 mg/kg	NV	EPA 8260 (volatile organic compounds)	≤30 ^r	70-130 ^r
71-43-2	Benzene	0.005 mg/kg ^k	18.2 mg/kg	0.00448 mg/kg	0.014 mg/kg			
56-23-5	Carbon tetrachloride	0.005 mg/kg ^k	7.69 mg/kg	0.031 mg/kg	0.0046 mg/kg			
67-66-3	Chloroform	0.005 mg/kg ^k	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
79-01-6	Trichloroethene	0.005 mg/kg ^k	11.2 mg/kg	0.00323 mg/kg	0.0355 mg/kg			
75-09-2	Methylene chloride	0.005 mg/kg	133 mg/kg	0.218 mg/kg	0.0409 mg/kg			
108-88-3	Toluene	0.005 mg/kg	6,400 mg/kg	4.65 mg/kg	99 mg/kg			
120-12-7	Anthracene	0.015 mg/kg	24,000 mg/kg	1,140 mg/kg	9,140 mg/kg	EPA 8310 (polynuclear aromatic hydrocarbons)	≤30 ^r	70-130 ^r
56-55-3	Benzo(a)anthracene	0.015 mg/kg	1.37 mg/kg	0.856 mg/kg	0.04 mg/kg			
50-32-8	Benzo(a)pyrene	0.015 mg/kg	0.137 mg/kg	2.33 mg/kg	0.109 mg/kg			
205-99-2	Benzo(b)fluoranthene	0.015 mg/kg	1.37 mg/kg	2.95 mg/kg	0.138 mg/kg			

Table 2-11. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-1

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
191-24-2	Benzo(ghi) perylene	0.03 mg/kg	2,400 mg/kg	25,700 mg/kg	7,070 mg/kg			
207-08-9	Benzo(k) fluoranthene	0.015 mg/kg	1.37 mg/kg	21.5 mg/kg	0.138 mg/kg			
218-01-9	Chrysene	0.1 mg/kg ^k	13.7 mg/kg	9.56 mg/kg	0.0446 mg/kg			
206-44-0	Fluoranthene	0.05 mg/kg	3,200 mg/kg	631 mg/kg	178 mg/kg			
193-39-5	Indeno(1,2,3-cd) pyrene	0.03 mg/kg	1.37 mg/kg	8.33 mg/kg	0.389 mg/kg			
85-01-8	Phenanthrene	0.05 mg/kg	24,000 mg/kg	1,140 mg/kg	9,100 mg/kg			
129-00-0	Pyrene	0.05 mg/kg	2,400 mg/kg	655 mg/kg	2,620 mg/kg			
7440-61-1	Uranium (total) ^s	1 mg/kg	240 mg/kg	3.21 mg/kg	3.21 mg/kg	UKPA or via isotopic	≤30 ^m	70-130 ^m
7440-38-2	Arsenic	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-39-3	Barium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-43-9	Cadmium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-47-3	Chromium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
18540-29-9	Hexavalent chromium	3.7 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 7196	≤30 ^m	70-130 ^m

Table 2-11. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-1

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7439-92-1	Lead	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-22-4	Silver	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7782-49-2	Selenium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
Performance Requirements for Physical Properties								
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937	N/A	N/A

Notes:

- a. Unless otherwise noted, Preliminary Cleanup Goals are established in WAC 173-340, "Model Toxics Control Act – Cleanup," 2007.
- b. Value includes a groundwater-to-river dilution attenuation factor of 2 based on the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE/RL-96-17, Rev. 6). A task is included in the *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* (DOE/RL-2008-46) to evaluate the appropriate dilution attenuation factor. Other considerations for analysis include WAC 173-340-730 (6)(b) (2007).

Table 2-11. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-1

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
c.	Equivalent methods may be substituted. For EPA Method 300.0, see EPA-600/4-79-020, <i>Methods for Chemical Analysis of Water and Wastes</i> . For EPA Method 200.8, see EPA-600/R-94-111, <i>Methods for the Determination of Metals in Environmental Samples, Supplement 1</i> . For the four-digit EPA methods, see SW-846, <i>Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B</i> .							
d.	Borehole will be logged with a neutron moisture tool and the high resolution, spectral gamma ray logging system. Geologic samples will also be logged. Vadose zone soil samples will be field-screened for gross alpha, gross beta, and gross gamma activities. Aquifer sediment samples will be field-screened for gross gamma activity.							
e.	Field measurements have no specific QC requirement for accuracy except to perform checks to verify manufacturer's expected performance.							
f.	Generic RESRAD modeling reported in DOE/RL-96-17, <i>Remedial Design Report/Remedial Action Work Plan for the 100 Area</i> , predicts the contaminant will not reach groundwater within 1,000 years; however, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.							
g.	Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.							
h.	The groundwater protection and river protection preliminary cleanup goal values for cesium-137, cobalt-60, technetium-99, tritium, and strontium-90 were established in DOE/RL-96-17, <i>Remedial Design Report/Remedial Action Work Plan for the 100 Area</i> , Revision 6.							
i.	The Uranium-233/234 and Uranium-238 groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site Background.							
j.	The Uranium-235 groundwater and river protection preliminary cleanup goal values are based on the recommended daily limit.							
k.	Calculated preliminary cleanup goals are less than established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.							
l.	Strontium-90 will be assessed as total radioactive strontium.							
m.	Accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.							
n.	To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if required detection limits are met.							
o.	The preliminary cleanup goal value for arsenic will be re-evaluated as described in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i> .							
p.	The manganese groundwater and river protection preliminary cleanup goal values are not risk based. They are based on Hanford site background.							
q.	A task is included in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i> to re-evaluate hexavalent chromium cleanup levels.							

Table 2-11. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-1

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
r. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control limits, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Method 8260.								
s. The uranium groundwater and river protection preliminary clean goal values are not risk-based. The values are based on Hanford Site background.								
ASTM D422-63, <i>Standard Test Method for Particle-Size Analysis of Soils</i> .								
ASTM D2216-05, <i>Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass</i> .								
ASTM D2434-68, <i>Standard Test Method for Permeability of Granular Soils (Constant Head)</i> .								
ASTM D2937, <i>Standard Test Method for Density of Soil in Place by Drive-Cylinder Method</i> .								
ASTM D5084-03, <i>Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter</i> .								
µg/L	=	micrograms per liter			MS	=	mass spectroscopy	
ASTM	=	American Society for Testing and Materials			N/A	=	not applicable	
cm ²	=	square centimeters			NV	=	no value	
CAS No.	=	Chemical Abstracts Service number			pCi/g	=	picoCuries per gram	
dpm	=	disintegrations per minute			QC	=	quality control	
EPA	=	U.S. Environmental Protection Agency			RESRAD	=	RESidual RADioactivity (dose model)	
IC	=	ion chromatography			TBD	=	to be determined	
ICP	=	inductively coupled plasma			UKPA	=	total uranium by kinetic phosphorescence analysis	
LSC	=	liquid scintillation counter			WAC	=	<i>Washington Administrative Code</i>	
mg/kg	=	milligrams per kilogram						

Table 2-12. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-2

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Field Measurements ^d								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	— ^e
12587-46-1	Gross alpha	100 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e
12587-47-2	Gross beta	5,000 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e
Performance Requirements for Laboratory Measurements (Radiological)								
10045-97-3	Cesium-137 ^f	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	Gamma energy analysis	≤30 ^g	70-130 ^g
10198-40-0	Cobalt-60 ^f	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV ^h	NV ^h			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV ^h	NV ^h			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV ^h	NV ^h			
15117-96-1	Uramium-235 ⁱ	1 pCi/g ^j	0.61 pCi/g	0.185 pCi/g	0.185 pCi/g	Isotopic – Uranium	≤30 ^g	70-130 ^g
—	Uranium-238 ^k	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g			
10098-97-2	Strontium-90 ^{f,l}	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30 ^g	70-130 ^g
—	Plutonium-239/240	1 pCi/g	33.9 pCi/g	NV ^h	NV ^h	Isotopic – Plutonium	≤30 ^g	70-130 ^g
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV ^h	NV ^h	LSC – Carbon-14	≤30 ^g	70-130 ^g
14133-76-7	Technetium-99 ^f	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC – Technetium-99	≤30 ^g	70-130 ^g
10028-17-8	Tritium ^f	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC – Tritium	≤30 ^g	70-130 ^g

Table 2-12. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-2

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Laboratory Measurements (Nonradiological)								
16984-48-8	Fluoride	5 mg/kg	4,800 mg/kg	2,880 mg/kg	5,770 mg/kg	EPA 300.0 (Anions by IC)	≤30 ^m	70-130 ^m
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg			
14808-79-8	Sulfate	5 mg/kg	NV	1,030 mg/kg	2,060 mg/kg			
7440-36-0	Antimony	6 mg/kg ⁿ	32 mg/kg	5.4 mg/kg	25.3 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30 ^m	70-130 ^m
7440-38-2	Arsenic ^o	10 mg/kg	TBD	TBD	TBD			
7440-39-3	Barium	2 mg/kg	16,000 mg/kg	1,650 mg/kg	3,300 mg/kg			
7440-43-9	Cadmium	0.5 mg/kg ⁿ	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-48-4	Cobalt ^p	2 mg/kg	24 mg/kg	15.7 mg/kg	NV			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese ^q	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7440-62-2	Vanadium	2.5 mg/kg	560 mg/kg	2,240 mg/kg	NV			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			
18540-29-9	Hexavalent chromium ^r	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Hexavalent chromium)	≤30 ^m	70-130 ^m

Table 2-12. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-2

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
53469-21-9	Aroclor-1242 (PCB)	0.017 mg/kg ^j	0.5 mg/kg	0.0394 mg/kg	0.000187 mg/g	EPA 8082 (PCBs by GC)	≤30 ^s	70-130 ^s
11096-82-5	Aroclor-1260 (PCB)	0.017 mg/kg ^j	0.5 mg/kg	0.721 mg/kg	0.00342 mg/kg			
71-43-2	Benzene	0.005 mg/kg ^j	18.2 mg/kg	0.00448 mg/kg	0.014 mg/kg	EPA 8260 (volatile organic compounds)	≤30 ^s	70-130 ^s
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
75-35-4	1,1-Dichloroethene	0.01 mg/kg ^j	1.67 mg/kg	0.0005 mg/kg	0.0008 mg/kg			
75-01-4	Vinyl Chloride	0.01 mg/kg ^j	0.667 mg/kg	0.00018 mg/kg	0.0252 mg/kg			
117-81-7	Bis(2-ethylhexyl) phthalate	0.33 mg/kg	71.4 mg/kg	13.9 mg/kg	8.01 mg/kg	EPA 8270 (semivolatile organic compounds)	≤30 ^s	70-130 ^s
84-74-2	di-n-Butyl phthalate	0.33 mg/kg	8,000 mg/kg	56.5 mg/kg	191 mg/kg			
7440-61-1	Uranium (total) ^t	1 mg/kg	240 mg/kg	3.21 mg/kg	3.21 mg/kg	UKPA or via isotopic	≤30 ^m	70-130 ^m
7440-38-2	Arsenic	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-39-3	Barium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-43-9	Cadmium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-47-3	Chromium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
18540-29-9	Hexavalent chromium	3.7 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 7196	≤30 ^m	70-130 ^m
7439-92-1	Lead	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m

Table 2-12. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-2

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7440-22-4	Silver	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7782-49-2	Selenium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
Performance Requirements for Physical Properties								
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937	N/A	N/A

Notes:

- Unless otherwise noted, Preliminary Cleanup Goals are established in WAC 173-340, "Model Toxics Control Act – Cleanup," 2007.
- Value includes a groundwater-to-river dilution attenuation factor of 2 based on the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE/RL-96-17, Rev. 6). A task is included in the *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* (DOE/RL-2008-46) to evaluate the appropriate dilution attenuation factor. Other considerations for analysis include WAC 173-340-730 (6)(b) (2007).
- Equivalent methods may be substituted. For EPA Method 300.0, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*. For EPA Method 200.8, see EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.
- Soils will be logged with a neutron moisture tool and the high resolution, spectral gamma ray logging system. Geologic samples will also be logged. Vadose zone soil samples will be field-screened for gross alpha, gross beta, and gross gamma activities. Aquifer sediment samples will be field-screened for gross gamma activity.

Table 2-12. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-2

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
e.	Field measurements have no specific QC requirement for accuracy except to perform checks to verify manufacturer's expected performance.							
f.	The groundwater protection and river protection preliminary cleanup goal values for cesium-137, cobalt-60, technetium-99, tritium, and strontium-90 were established in DOE/RL-96-17, <i>Remedial Design Report/Remedial Action Work Plan for the 100 Area</i> , Revision 6.							
g.	Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.							
h.	Generic RESRAD modeling reported in DOE/RL-96-17, <i>Remedial Design Report/Remedial Action Work Plan for the 100 Area</i> , predicts the contaminant will not reach groundwater within 1,000 years; however, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.							
i.	The Uranium-235 groundwater and river protection preliminary cleanup goal values are based on the recommended daily limit.							
j.	Calculated preliminary cleanup goals are less than established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.							
k.	The Uranium-238 groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site Background.							
l.	Strontium-90 will be assessed as total radioactive strontium.							
m.	Accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.							
n.	To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if estimated quantitation limits are met.							
o.	The preliminary cleanup goal value for arsenic will be re-evaluated as described in the <i>Integrated DOE/RL-2008-46, 100 Area Remedial Investigation/Feasibility Study Work Plan</i> .							
p.	Cobalt groundwater and river protection preliminary cleanup goal values are based on Hanford Site background values.							
q.	Manganese groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site background values.							
r.	A task is included in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i> to re-evaluate hexavalent chromium cleanup levels.							
s.	Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control limits, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Methods 8260 and 8270.							
t.	The uranium groundwater protection and river protection preliminary clean goal values are not risk-based. The values are based on Hanford Site background.							
ASTM D422-63, <i>Standard Test Method for Particle-Size Analysis of Soils</i> .								
ASTM D2216-05, <i>Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass</i> .								

Table 2-12. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-2

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
ASTM D2434-68, <i>Standard Test Method for Permeability of Granular Soils (Constant Head)</i> .								
ASTM D2937, <i>Standard Test Method for Density of Soil in Place by Drive-Cylinder Method</i> .								
ASTM D5084-03, <i>Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter</i> .								
µg/L	=	micrograms per liter			MS	=	mass spectroscopy	
ASTM	=	American Society for Testing and Materials			N/A	=	not applicable	
cm ²	=	square centimeters			NV	=	no value	
CAS No.	=	Chemical Abstracts Service number			PCB	=	polychlorinated biphenyl	
dpm	=	disintegrations per minute			pCi/g	=	picoCuries per gram	
EPA	=	U.S. Environmental Protection Agency			QC	=	quality control	
GC	=	gas chromatography			RESRAD	=	RESidual RADioactivity (dose model)	
IC	=	ion chromatography			TBD	=	to be determined	
ICP	=	inductively coupled plasma			UKPA	=	total uranium by kinetic phosphorescence analysis	
LSC	=	liquid scintillation counter			WAC	=	<i>Washington Administrative Code</i>	
mg/kg	=	milligrams per kilogram						

Table 2-13. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Field Measurements ^d								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	— ^e
12587-46-1	Gross alpha	100 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e

Table 2-13. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
12587-47-2	Gross beta	5,000 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e
Performance Requirements for Laboratory Measurements (Radiological)								
13967-70-9	Cesium-134	0.1 pCi/g	N/A	N/A	N/A	Gamma energy analysis	≤30 ^f	70-130 ^f
10198-40-0	Cobalt-60 ^h	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV ^g	NV ^g			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV ^g	NV ^g			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV ^g	NV ^g			
15117-96-1	Uranium-235 ^h	1 pCi/g ⁱ	0.61 pCi/g	0.185 pCi/g	0.185 pCi/g	Isotopic – Uranium	≤30 ^f	70-130 ^f
—	Uranium-238 ^j	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g			
14596-10-2	Americium-241	1 pCi/g	31.1 pCi/g	NV ^g	NV ^g	Americium-241/ Curium-244	≤30 ^f	70-130 ^f
10098-97-2	Strontium-90 ^{k,l}	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30 ^f	70-130 ^f
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV ^g	NV ^g	LSC – Carbon-14	≤30 ^f	70-130 ^f
14133-76-7	Technetium-99 ^h	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC – Technetium-99	≤30 ^f	70-130 ^f
10028-17-8	Tritium ^h	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC – Tritium	≤30 ^f	70-130 ^f
13981-16-3	Plutonium-238	1 pCi/g	37.4 pCi/g	NV ^g	NV ^g	Isotopic – Plutonium	≤30 ^f	70-130 ^f
—	Plutonium-239/ 240	1 pCi/g	33.9 pCi/g	NV ^g	NV ^g	Isotopic – Plutonium	≤30 ^f	70-130 ^f

Table 2-13. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Laboratory Measurements (Nonradiological)								
16984-48-8	Fluoride	5 mg/kg	4,800 mg/kg	2,880 mg/kg	5,770 mg/kg	EPA 300.0 (anions by IC)	≤30 ^m	70-130 ^m
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg			
14797-65-0	Nitrite (as N)	2.5 mg/kg	8,000 mg/kg	4 mg/kg	8 mg/kg			
14808-79-8	Sulfate	5 mg/kg	NV	1,030 mg/kg	2,060 mg/kg			
7440-36-0	Antimony	6 mg/kg ⁿ	32 mg/kg	5.4 mg/kg	25.3 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30 ^m	70-130 ^m
7440-38-2	Arsenic ^o	10 mg/kg	TBD	TBD	TBD			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-39-3	Barium	2 mg/kg	16,000 mg/kg	1,650 mg/kg	3,300 mg/kg			
7440-43-9	Cadmium	0.5 mg/kg ⁿ	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-48-4	Cobalt ^p	2 mg/kg	24 mg/kg	15.7 mg/kg	NV			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese ^q	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg ⁿ	400 mg/kg	5.2 mg/kg	1.04 mg/kg			
7440-22-4	Silver	1 mg/kg ⁿ	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg ⁿ	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			

Table 2-13. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7440-62-2	Vanadium	2.5 mg/kg	560 mg/kg	2,240 mg/kg	NV			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 (mercury by cold vapor)	≤30 ^m	70-130 ^m
18540-29-9	Hexavalent chromium ^r	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Hexavalent chromium)	≤30 ^m	70-130 ^m
71-43-2	Benzene	0.005 mg/kg ⁱ	18.2 mg/kg	0.00448 mg/kg	0.014 mg/kg	EPA 8260 (volatile organic compounds)	≤30 ^s	70-130 ^s
56-23-5	Carbon tetrachloride	0.005 mg/kg ⁱ	7.69 mg/kg	0.031 mg/kg	0.0046 mg/kg			
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
79-01-6	Trichloroethene	0.005 mg/kg ⁱ	11.2 mg/kg	0.00323 mg/kg	0.0355 mg/kg			
7440-61-1	Uranium (total) ^t	1 mg/kg	240 mg/kg	3.21 mg/kg	3.21 mg/kg	UKPA or via isotopic	≤30 ^m	70-130 ^m
7440-38-2	Arsenic	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-39-3	Barium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-43-9	Cadmium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-47-3	Chromium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
18540-29-9	Hexavalent chromium	3.7 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 7196	≤30 ^m	70-130 ^m

Table 2-13. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7439-92-1	Lead	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-22-4	Silver	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7782-49-2	Selenium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
Performance Requirements for Physical Properties								
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937	N/A	N/A

Notes:

- a. Unless otherwise noted, Preliminary Cleanup Goals are established in WAC 173-340, "Model Toxics Control Act – Cleanup," 2007.
- b. Value includes a groundwater-to-river dilution attenuation factor of 2 based on the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE/RL-96-17, Rev. 6). A task is included in the *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* (DOE/RL-2008-46) to evaluate the appropriate dilution attenuation factor. Other considerations for analysis include WAC 173-340-730 (6)(b) (2007).

Table 2-13. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
<p>c. Equivalent methods may be substituted. For EPA Method 300.0, see EPA-600/4-79-020, <i>Methods for Chemical Analysis of Water and Wastes</i>. For EPA Method 200.8, see EPA-600/R-94-111, <i>Methods for the Determination of Metals in Environmental Samples, Supplement 1</i>. For the four-digit EPA methods, see SW-846, <i>Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B</i>.</p> <p>d. Borehole will be logged with a neutron moisture tool and the high resolution, spectral gamma ray logging system. Geologic samples will also be logged. Vadose zone soil samples will be field-screened for gross alpha, gross beta, and gross gamma activities. Aquifer sediment samples will be field-screened for gross gamma activity.</p> <p>e. Field measurements have no specific QC requirement for accuracy except to perform checks to verify manufacturer's expected performance.</p> <p>f. Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.</p> <p>g. Generic RESRAD modeling reported in DOE/RL-96-17, <i>Remedial Design Report/Remedial Action Work Plan for the 100 Area</i>, predicts the contaminant will not reach groundwater within 1,000 years; however, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.</p> <p>h. The Uranium-235 groundwater and river protection preliminary cleanup goal values are based on the recommended daily limit.</p> <p>i. Calculated cleanup goals are less than established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.</p> <p>j. The Uranium-238 groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site Background.</p> <p>k. Strontium-90 will be assessed as total radioactive strontium.</p> <p>l. The groundwater protection and river protection preliminary cleanup goal values for cobalt-60, technetium-99, tritium, and strontium-90 were established in DOE/RL-96-17, <i>Remedial Design Report/Remedial Action Work Plan for the 100 Area</i>, Revision 6.</p> <p>m. Accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.</p> <p>n. To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if estimated quantitation limits are met.</p> <p>o. The preliminary cleanup goal value for arsenic will be re-evaluated as described in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i>.</p> <p>p. Cobalt groundwater and river protection preliminary cleanup goal values are based on Hanford Site background values.</p> <p>q. Manganese groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site background values.</p> <p>r. A task is included in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i> to re-evaluate hexavalent chromium cleanup levels.</p>								

Table 2-13. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			

s. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control limits, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Method 8260.

t. The uranium groundwater and river protection preliminary clean goal values are not risk-based. The values are based on Hanford Site background.

ASTM D422-63, *Standard Test Method for Particle-Size Analysis of Soils*.

ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*.

ASTM D2434-68, *Standard Test Method for Permeability of Granular Soils (Constant Head)*.

ASTM D2937, *Standard Test Method for Density of Soil in Place by Drive-Cylinder Method*.

ASTM D5084-03, *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*.

µg/L = micrograms per liter

ASTM = American Society for Testing and Materials

cm² = square centimeters

CAS No. = Chemical Abstracts Service number

dpm = disintegrations per minute

EPA = U.S. Environmental Protection Agency

IC = ion chromatography

ICP = inductively coupled plasma

LSC = liquid scintillation counter

mg/kg = milligrams per kilogram

MS = mass spectroscopy

N/A = not applicable

NV = no value

pCi/g = picoCuries per gram

QC = quality control

RESRAD = RESidual RADioactivity (dose model)

TBD = to be determined

UKPA = total uranium by kinetic phosphorescence analysis

WAC = *Washington Administrative Code*

Table 2-14. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-6

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Field Measurements ^d								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	— ^e
12587-46-1	Gross alpha	100 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e
12587-47-2	Gross beta	5,000 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e
Performance Requirements for Laboratory Measurements (Radiological)								
14596-10-2	Americium-241	1 pCi/g	31.1 pCi/g	NV ^f	NV ^f	Americium-241/ Curium-244	≤30 ^g	70-130 ^g
10045-97-3	Cesium-137 ^h	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	Gamma energy analysis	≤30 ^g	70-130 ^g
10198-40-0	Cobalt-60 ^h	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV ^f	NV ^f			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV ^f	NV ^f			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV ^f	NV ^f			
—	Uranium-233/234 ⁱ	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g	Isotopic – Uranium	≤30 ^g	70-130 ^g
15117-96-1	Uranium-235 ^j	1 pCi/g ^k	0.61 pCi/g	0.185 pCi/g	0.185 pCi/g			
—	Uranium-238 ⁱ	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g			
10098-97-2	Strontium-90 ^{h,i}	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30 ^g	70-130 ^g
14133-76-7	Technetium-99 ^h	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC – Technetium-99	≤30 ^g	70-130 ^g

Table 2-14. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-6

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
10028-17-8	Tritium ^h	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC – Tritium	≤30 ^g	70-130 ^g
Performance Requirements for Laboratory Measurements (Nonradiological)								
16984-48-8	Fluoride	5 mg/kg	4,800 mg/kg	2,880 mg/kg	5,770 mg/kg	EPA 300.0 (Anions by IC)	≤30 ^m	70-130 ^m
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg			
14808-79-8	Sulfate	5 mg/kg	NV	1,030 mg/kg	2,060 mg/kg			
57-12-5	Cyanide	0.5 mg/kg	1,600 mg/kg	0.800 mg/kg	1.6 mg/kg	EPA 9012	≤30 ^m	70-130 ^m
7440-38-2	Arsenic ⁿ	10 mg/kg	TBD	TBD	TBD	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30 ^m	70-130 ^m
7440-39-3	Barium	2 mg/kg	16,000 mg/kg	1,650 mg/kg	3,300 mg/kg			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-48-4	Cobalt ^o	2 mg/kg	24 mg/kg	15.7 mg/kg	NV			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1150 mg/kg			
7439-96-5	Manganese ^p	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg ^q	400 mg/kg	5.2 mg/kg	1.04 mg/kg			
7440-22-4	Silver	1 mg/kg ^q	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg ^q	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-62-2	Vanadium	2.5 mg/kg	560 mg/kg	2,240 mg/kg	NV			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			

Table 2-14. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-6

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
18540-29-9	Hexavalent chromium ^r	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Hexavalent chromium)	≤30 ^m	70-130 ^m
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 (mercury by cold vapor)	≤30 ^m	70-130 ^m
71-55-6	1,1,1-Trichloroethane	0.005 mg/kg	165,000 mg/kg	1.58 mg/kg	3.17 mg/kg	EPA 8260 (volatile organic compounds)	≤30 ^s	70-130 ^s
75-35-4	1,1-Dichloroethene	0.01 mg/kg ^k	1.67 mg/kg	0.0005 mg/kg	0.0008 mg/kg			
78-93-3	2-Butanone	0.01 mg/kg	NV	48,000 mg/kg	19.6 mg/kg			
591-78-6	2-Hexanone	0.02 mg/kg	3,200 mg/kg	2.73 mg/kg	NV			
108-10-1	4-Methyl-2-pentanone	0.01 mg/kg	6,400 mg/kg	2.71 mg/kg	NV			
67-64-1	Acetone	0.02 mg/kg	72,000 mg/kg	28.9 mg/kg	NV			
71-43-2	Benzene	0.005 mg/kg ^k	18.2 mg/kg	0.00448 mg/kg	0.014 mg/kg			
56-23-5	Carbon tetrachloride	0.005 mg/kg ^k	7.69 mg/kg	0.031 mg/kg	0.0046 mg/kg			
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
100-41-4	Ethylbenzene	0.005 mg/kg	8,000 mg/kg	6.05 mg/kg	53.6 mg/kg			
75-09-2	Methylene chloride	0.005 mg/kg	133 mg/kg	0.218 mg/kg	0.0409 mg/kg			
127-18-4	Tetrachloroethene	0.005 mg/kg	1.85 mg/kg	0.008 mg/kg	0.008 mg/kg			
156-60-5	trans-1,2-Dichloroethylene	0.005 mg/kg	1,600 mg/kg	0.54 mg/kg	356 mg/kg			
79-01-6	Trichloroethene	0.005 mg/kg ^k	11.2 mg/kg	0.00323 mg/kg	0.0355 mg/kg			
75-01-4	Vinyl Chloride	0.01 mg/kg ^k	0.667 mg/kg	0.00018 mg/kg	0.0252 mg/kg			

Table 2-14. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-6

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
1330-20-7	Xylenes (total)	0.01 mg/kg	16,000 mg/kg	3.09 mg/kg	10.3 mg/kg			
7440-61-1	Uranium (total) [†]	1 mg/kg	240 mg/kg	3.21 mg/kg	3.21 mg/kg	UKPA or via isotopic	≤30 ^m	70-130 ^m
7440-38-2	Arsenic	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-39-3	Barium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-43-9	Cadmium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-47-3	Chromium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
18540-29-9	Hexavalent chromium	3.7 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 7196	≤30 ^m	70-130 ^m
7439-92-1	Lead	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-22-4	Silver	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7782-49-2	Selenium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m

Table 2-14. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-6

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Physical Properties								
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937	N/A	N/A

Notes:

- Unless otherwise noted, Preliminary Cleanup Goals are established in *Washington Administrative Code* (WAC) 173-340, "Model Toxics Control Act – Cleanup," 2007.
- Value includes a groundwater-to-river dilution attenuation factor of 2 based on the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE/RL-96-17, Rev. 6). A task is included in the *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* (DOE/RL-2008-46) to evaluate the appropriate dilution attenuation factor. Other considerations for analysis include WAC 173-340-730 (6)(b) (2007).
- Equivalent methods may be substituted. For EPA Method 300.0, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*. For EPA Method 200.8, see EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.
- Borehole will be logged with a neutron moisture tool and the high resolution, spectral gamma ray logging system. Geologic samples will also be logged. Vadose zone soil samples will be field-screened for gross alpha, gross beta, and gross gamma activities. Aquifer sediment samples will be field-screened for gross gamma activity.
- Field measurements have no specific QC requirement for accuracy except to perform checks to verify manufacturer's expected performance.
- Generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years; however, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.

Table 2-14. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-6

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
<p>g. Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.</p> <p>h. The groundwater protection and river protection preliminary cleanup goal values for cesium-137, cobalt-60, technetium-99, tritium, and strontium-90 were established in DOE/RL-96-17, <i>Remedial Design Report/Remedial Action Work Plan for the 100 Area</i>, Revision 6.</p> <p>i. The Uranium-233/234 and Uranium-238 groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site Background.</p> <p>j. The Uranium-235 groundwater and river protection preliminary cleanup goal values are based on the recommended daily limit.</p> <p>k. Calculated preliminary cleanup goals are less than established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.</p> <p>l. Strontium-90 will be assessed as total radioactive strontium.</p> <p>m. Accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.</p> <p>n. The preliminary cleanup goal value for arsenic will be re-evaluated as described in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i>.</p> <p>o. Cobalt groundwater and river protection preliminary cleanup goal values are based on Hanford Site background values.</p> <p>p. Manganese groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site background values.</p> <p>q. To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if estimated quantitation limits are met.</p> <p>r. A task is included in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i> to re-evaluate hexavalent chromium cleanup levels.</p> <p>s. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control limits, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Method 8260.</p> <p>t. The uranium groundwater and river protection preliminary clean goal values are not risk-based. The values are based on Hanford Site background.</p> <p>ASTM D422-63, <i>Standard Test Method for Particle-Size Analysis of Soils</i>.</p> <p>ASTM D2216-05, <i>Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass</i>.</p> <p>ASTM D2434-68, <i>Standard Test Method for Permeability of Granular Soils (Constant Head)</i>.</p> <p>ASTM D2937, <i>Standard Test Method for Density of Soil in Place by Drive-Cylinder Method</i>.</p> <p>ASTM D5084-03, <i>Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter</i>.</p>								

Table 2-14. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-6

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
µg/L	=	micrograms per liter			mg/kg	=	milligrams per kilogram	
ASTM	=	American Society for Testing and Materials			MS	=	mass spectroscopy	
cm ²	=	square centimeters			N/A	=	not applicable	
CAS No.	=	Chemical Abstracts Service number			NV	=	no value	
dpm	=	disintegrations per minute			pCi/g	=	picoCuries per gram	
EPA	=	U.S. Environmental Protection Agency			QC	=	quality control	
IC	=	ion chromatography			RESRAD	=	RESidual RADioactivity (dose model)	
ICP	=	inductively coupled plasma			TBD	=	to be determined	
LSC	=	liquid scintillation counter			UKPA	=	total uranium by kinetic phosphorescence analysis	

Table 2-15. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-7

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Field Measurements ^d								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	— ^e
12587-46-1	Gross alpha	100 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e
12587-47-2	Gross beta	5,000 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e

Table 2-15. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-7

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Laboratory Measurements (Radiological)								
10045-97-3	Cesium-137 ^f	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	Gamma energy analysis	≤30 ^g	70-130 ^g
10198-40-0	Cobalt-60 ^f	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV ^h	NV ^h			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV ^h	NV ^h			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV ^h	NV ^h			
—	Uranium-233/234 ⁱ	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g	Isotopic – Uranium	≤30 ^g	70-130 ^g
15117-96-1	Uranium-235 ^j	1 pCi/g ^k	0.61 pCi/g	0.185 pCi/g	0.185 pCi/g			
—	Uranium-238 ⁱ	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g			
10098-97-2	Strontium-90 ^{f,i}	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30 ^g	70-130 ^g
13981-16-3	Plutonium-238	1 pCi/g	37.4 pCi/g	NV ^h	NV ^h	Isotopic – Plutonium	≤30 ^g	70-130 ^g
—	Plutonium-239/240	1 pCi/g	33.9 pCi/g	NV ^h	NV ^h			
14596-10-2	Americium-241	1 pCi/g	31.1 pCi/g	NV ^h	NV ^h	Americium-241/ Curium-244	≤30 ^g	70-130 ^g
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV ^h	NV ^h	LSC – Carbon-14	≤30 ^g	70-130 ^g
13981-37-8	Nickel-63 ^f	30 pCi/g	4,026 pCi/g	83 pCi/g	166 pCi/g	LSC – Nickel-63	≤30 ^g	70-130 ^g
14133-76-7	Technetium-99 ^f	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC – Technetium-99	≤30 ^g	70-130 ^g
10028-17-8	Tritium ^f	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC – Tritium	≤30 ^g	70-130 ^g

Table 2-15. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-7

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Laboratory Measurements (Nonradiological)								
16984-48-8	Fluoride	5 mg/kg	4,800 mg/kg	2,880 mg/kg	5,770 mg/kg	EPA 300.0 (Anions by IC)	≤30 ^m	70-130 ^m
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg			
14797-65-0	Nitrite (as N)	2.5 mg/kg	8,000 mg/kg	4 mg/kg	8 mg/kg			
14808-79-8	Sulfate	5 mg/kg	NV	1,030 mg/kg	2,060 mg/kg			
7440-36-0	Antimony	6 mg/kg ⁿ	32 mg/kg	5.4 mg/kg	25.3 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30 ^m	70-130 ^m
7440-38-2	Arsenic ^o	10 mg/kg	TBD	TBD	TBD			
7440-39-3	Barium	2 mg/kg	16,000 mg/kg	1,650 mg/kg	3,300 mg/kg			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-43-9	Cadmium	0.5 mg/kg ⁿ	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-48-4	Cobalt ^p	2 mg/kg	24 mg/kg	15.7 mg/kg	NV			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese ^q	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg ⁿ	400 mg/kg	5.2 mg/kg	1.04 mg/kg			

Table 2-15. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-7

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7440-22-4	Silver	1 mg/kg ⁿ	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg ⁿ	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-62-2	Vanadium	2.5 mg/kg	560 mg/kg	2,240 mg/kg	NV			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			
18540-29-9	Hexavalent chromium ^r	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (hexavalent chromium)	≤30 ^m	70-130 ^m
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 (mercury by cold vapor)	≤30 ^m	70-130 ^m
53469-21-9	Aroclor-1242 (PCB)	0.017 mg/kg ^k	0.5 mg/kg	0.0394 mg/kg	0.000187 mg/kg	EPA 8082 (PCB by GC)	≤30 ^s	70-130 ^s
11096-82-5	Aroclor-1260 (PCB)	0.017 mg/kg ^k	0.5 mg/kg	0.721 mg/kg	0.00342 mg/kg			
71-43-2	Benzene	0.005 mg/kg ^k	18.2 mg/kg	0.00448 mg/kg	0.014 mg/kg	EPA 8260 (volatile organic compounds)	≤30 ^s	70-130 ^s
56-23-5	Carbon tetrachloride	0.005 mg/kg ^k	7.69 mg/kg	0.031 mg/kg	0.0046 mg/kg			
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
75-35-4	1,1-Dichloroethene	0.01 mg/kg ^k	1.67 mg/kg	0.0005 mg/kg	0.0008 mg/kg			
79-01-6	Trichloroethene	0.005 mg/kg ^k	11.2 mg/kg	0.00323 mg/kg	0.0355 mg/kg			
108-88-3	Toluene	0.005 mg/kg	6,400 mg/kg	4.65 mg/kg	99 mg/kg			
75-01-4	Vinyl Chloride	0.01 mg/kg ^k	0.667 mg/kg	0.00018 mg/kg	0.0252 mg/kg			
7440-61-1	Uranium (total) ^t	1 mg/kg	240 mg/kg	3.21 mg/kg	3.21 mg/kg	UKPA or via isotopic	≤30 ^m	70-130 ^m

Table 2-15. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-7

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7440-38-2	Arsenic	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-39-3	Barium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-43-9	Cadmium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-47-3	Chromium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
18540-29-9	Hexavalent chromium	3.7 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 7196	≤30 ^m	70-130 ^m
7439-92-1	Lead	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-22-4	Silver	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7782-49-2	Selenium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
Performance Requirements for Physical Properties								
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A

Table 2-15. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-7

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937	N/A	N/A

Notes:

- Unless otherwise noted, Preliminary Cleanup Goals are established in WAC 173-340, "Model Toxics Control Act – Cleanup," 2007.
- Value includes a groundwater-to-river dilution attenuation factor of 2 based on the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE/RL-96-17, Rev. 6). A task is included in the *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* (DOE/RL-2008-46) to evaluate the appropriate dilution attenuation factor. Other considerations for analysis include WAC 173-340-730 (6)(b) (2007).
- Equivalent methods may be substituted. For EPA Method 300.0, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*. For EPA Method 200.8, see EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.
- Borehole will be logged with a neutron moisture tool and the high resolution, spectral gamma ray logging system. Geologic samples will also be logged. Vadose zone soil samples will be field-screened for gross alpha, gross beta, and gross gamma activities. Aquifer sediment samples will be field-screened for gross gamma activity.
- Field measurements have no specific QC requirement for accuracy except to perform checks to verify manufacturer's expected performance.
- The groundwater protection and river protection preliminary cleanup goal values for cesium-137, cobalt-60, technetium-99, tritium, strontium-90, and nickel-63 were established in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Revision 6.
- Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.
- Generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years; however, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.

Table 2-15. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-7

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
i.	The Uranium-233/234 and Uranium-238 groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site Background.							
j.	The Uranium-235 groundwater and river protection preliminary cleanup goal values are based on the recommended daily limit.							
k.	Calculated preliminary cleanup goals are less than established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.							
l.	Strontium-90 will be assessed as total radioactive strontium.							
m.	Accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.							
n.	To meet or approach calculated cleanup goals, laboratories must use axial-based (“trace”) ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if estimated quantitation limits are met.							
o.	The preliminary cleanup goal value for arsenic will be re-evaluated as described in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i> .							
p.	Cobalt groundwater and river protection preliminary cleanup goal values are based on Hanford Site background values.							
q.	The manganese groundwater and river protection preliminary cleanup goal values are not risk based. They are based on Hanford site background.							
r.	A task is included in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i> to re-evaluate hexavalent chromium cleanup levels.							
s.	Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control limits, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Method 8260.							
t.	The uranium groundwater and river protection preliminary clean goal values are not risk-based. The values are based on Hanford Site background.							
ASTM D422-63, <i>Standard Test Method for Particle-Size Analysis of Soils</i> .								
ASTM D2216-05, <i>Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass</i> .								
ASTM D2434-68, <i>Standard Test Method for Permeability of Granular Soils (Constant Head)</i> .								
ASTM D2937, <i>Standard Test Method for Density of Soil in Place by Drive-Cylinder Method</i> .								
ASTM D5084-03, <i>Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter</i> .								

Table 2-15. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-H-7

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
µg/L	=	micrograms per liter			MS	=	mass spectroscopy	
ASTM	=	American Society for Testing and Materials			N/A	=	not applicable	
cm ²	=	square centimeters			NV	=	no value	
CAS No.	=	Chemical Abstracts Service number			PCB	=	polychlorinated biphenyl	
dpm	=	disintegrations per minute			RESRAD	=	RESidual RADioactivity (dose model)	
GC	=	gas chromatography			TBD	=	to be determined	
IC	=	ion chromatography			UKPA	=	total uranium by kinetic phosphorescence analysis	
ICP	=	inductively coupled plasma			WAC	=	<i>Washington Administrative Code</i>	
LSC	=	liquid scintillation counter						

Table 2-16. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-H-6

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Field Measurements ^d								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	— ^e
12587-46-1	Gross alpha	100 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e
12587-47-2	Gross beta	5,000 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e

Table 2-16. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-H-6

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Laboratory Measurements (Radiological)								
14596-10-2	Americium-241	1 pCi/g	31.1 pCi/g	NV ^f	NV ^f	Americium-241/ Curium-244	≤30 ^g	70-130 ^g
10045-97-3	Cesium-137 ^h	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	Gamma energy analysis	≤30 ^g	70-130 ^g
10198-40-0	Cobalt-60 ^h	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV ^f	NV ^f			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV ^f	NV ^f			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV ^f	NV ^f			
—	Uranium-233/234 ⁱ	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g	Isotopic – Uranium	≤30 ^g	70-130 ^g
15117-96-1	Uranium-235 ^j	0.5 pCi/g ^k	0.61 pCi/g	0.185 pCi/g	0.185 pCi/g			
—	Uranium-238 ^l	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g			
10098-97-2	Strontium-90 ^{h,i}	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30 ^g	70-130 ^g
13981-16-3	Plutonium-238	1 pCi/g	37.4 pCi/g	NV ^f	NV ^f	Isotopic – Plutonium	≤30 ^g	70-130 ^g
—	Plutonium-239/ 240	1 pCi/g	33.9 pCi/g	NV ^f	NV ^f			
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV ^f	NV ^f	LSC – Carbon-14	≤30 ^g	70-130 ^g
13981-37-8	Nickel-63 ^h	30 pCi/g	4,026 pCi/g	83 pCi/g	166 pCi/g	LSC – Nickel-63	≤30 ^g	70-130 ^g
14133-76-7	Technetium-99 ^h	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC – Technetium-99	≤30 ^g	70-130 ^g
10028-17-8	Tritium ^h	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC – Tritium	≤30 ^g	70-130 ^g
13994-20-2	Neptunium-237 ^h	1 pCi/g ^k	2.44 pCi/g	0.9 pCi/g	1.80 pCi/g	Atomic energy absorption	≤30 ^g	70-130 ^g

Table 2-16. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-H-6

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Laboratory Measurements (Nonradiological)								
16984-48-8	Fluoride	5 mg/kg	4,800 mg/kg	2,880 mg/kg	5,770 mg/kg	EPA 300.0 (Anions by IC)	≤30 ^m	70-130 ^m
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg			
14797-65-0	Nitrite (as N)	2.5 mg/kg	8,000 mg/kg	4 mg/kg	8 mg/kg			
14808-79-8	Sulfate	5 mg/kg	NV	1,030 mg/kg	2,060 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30 ^m	70-130 ^m
7440-36-0	Antimony	6 mg/kg ⁿ	32 mg/kg	5.4 mg/kg	25.3 mg/kg			
7440-38-2	Arsenic ^o	10 mg/kg	TBD	TBD	TBD			
7440-39-3	Barium	2 mg/kg	16,000 mg/kg	1,650 mg/kg	3,300 mg/kg			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-43-9	Cadmium	0.5 mg/kg ⁿ	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-48-4	Cobalt ^p	2 mg/kg	24 mg/kg	15.7 mg/kg	NV			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese ^q	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg ⁿ	400 mg/kg	5.2 mg/kg	1.04 mg/kg			
7440-22-4	Silver	1 mg/kg ⁿ	400 mg/kg	13.6 mg/kg	0.884 mg/kg			

Table 2-16. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-H-6

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7440-28-0	Thallium	5 mg/kg ⁿ	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-62-2	Vanadium	2.5 mg/kg	560 mg/kg	2,240 mg/kg	NV			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			
18540-29-9	Hexavalent chromium ^f	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Hexavalent chromium)	≤30 ^m	70-130 ^m
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 (mercury by cold vapor)	≤30 ^m	70-130 ^m
12674-11-2	Aroclor-1016 (PCB)	0.017 mg/kg ^k	0.5 mg/kg	0.0942 mg/kg	0.000447 mg/kg	EPA 8082 (PCB by GC)	≤30 ^s	70-130 ^s
11104-28-2	Aroclor-1221 (PCB)	0.017 mg/kg ^k	0.5 mg/kg	0.00920 mg/kg	0.0000437 mg/kg			
11141-16-5	Aroclor-1232 (PCB)	0.017 mg/kg ^k	0.5 mg/kg	0.00920 mg/kg	0.0000437 mg/kg			
53469-21-9	Aroclor-1242 (PCB)	0.017 mg/kg ^k	0.5 mg/kg	0.0394 mg/kg	0.000187 mg/kg			
12672-29-6	Aroclor-1248 (PCB)	0.017 mg/kg ^k	0.5 mg/kg	0.0386 mg/kg	0.000183 mg/kg			
11097-69-1	Aroclor-1254 (PCB)	0.017 mg/kg ^k	0.5 mg/kg	0.0664 mg/kg	0.000315 mg/kg			
11096-82-5	Aroclor-1260 (PCB)	0.017 mg/kg ^k	0.5 mg/kg	0.721 mg/kg	0.00342 mg/kg			
71-43-2	Benzene	0.005 mg/kg ^k	18.2 mg/kg	0.00448 mg/kg	0.014 mg/kg	EPA 8260 (volatile organic compounds)	≤30 ^s	70-130 ^s
56-23-5	Carbon tetrachloride	0.005 mg/kg ^k	7.69 mg/kg	0.031 mg/kg	0.0046 mg/kg			

Table 2-16. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-H-6

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
79-01-6	Trichloroethene	0.005 mg/kg ^k	11.2 mg/kg	0.00323 mg/kg	0.0355 mg/kg			
7440-61-1	Uranium (total) ^t	1 mg/kg	240 mg/kg	3.21 mg/kg	3.21 mg/kg	UKPA or via isotopic	≤30 ^m	70-130 ^m
7440-38-2	Arsenic	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-39-3	Barium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-43-9	Cadmium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-47-3	Chromium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
18540-29-9	Hexavalent chromium	3.7 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 7196	≤30 ^m	70-130 ^m
7439-92-1	Lead	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7440-22-4	Silver	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
7782-49-2	Selenium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^m	70-130 ^m
Performance Requirements for Physical Properties								
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A

Table 2-16. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-H-6

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937	N/A	N/A

Notes:

- Unless otherwise noted, Preliminary Cleanup Goals are established in WAC 173-340, "Model Toxics Control Act – Cleanup," 2007.
- Value includes a groundwater-to-river dilution attenuation factor of 2 based on the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE/RL-96-17, Rev. 6). A task is included in the *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* (DOE/RL-2008-46) to evaluate the appropriate dilution attenuation factor. Other considerations for analysis include WAC 173-340-730 (6)(b) (2007).
- Equivalent methods may be substituted. For EPA Method 300.0, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*. For EPA Method 200.8, see EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.
- Borehole will be logged with a neutron moisture tool and the high resolution, spectral gamma ray logging system. Geologic samples will also be logged. Vadose zone soil samples will be field-screened for gross alpha, gross beta, and gross gamma activities. Aquifer sediment samples will be field-screened for gross gamma activity.
- Field measurements have no specific QC requirement for accuracy except to perform checks to verify manufacturer's expected performance.
- Generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years; however, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.
- Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.
- The groundwater protection and river protection preliminary cleanup goal values for cesium-137, cobalt-60, neptunium-237, technetium-99, tritium, strontium-90, and nickel-63 were established in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Revision 6.

Table 2-16. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-H-6

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
i.	The Uranium-233/234 and Uranium-238 groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site Background.							
j.	The Uranium-235 groundwater and river protection preliminary cleanup goal values are based on the recommended daily limit.							
k.	Calculated cleanup goals are less than established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.							
l.	Strontium-90 will be assessed as total radioactive strontium.							
m.	Accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.							
n.	To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if estimated quantitation limits are met.							
o.	The preliminary cleanup goal value for arsenic will be re-evaluated as described in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i> .							
p.	Cobalt groundwater and river protection preliminary cleanup goal values are based on Hanford Site background values.							
q.	The manganese groundwater and river protection preliminary cleanup goal values are not risk based. They are based on Hanford site background.							
r.	A task is included in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i> to re-evaluate hexavalent chromium cleanup levels.							
s.	Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control limits, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Method 8260.							
t.	The uranium groundwater and river protection preliminary clean goal values are not risk-based. The values are based on Hanford Site background.							
ASTM D422-63, <i>Standard Test Method for Particle-Size Analysis of Soils</i> .								
ASTM D2216-05, <i>Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass</i> .								
ASTM D2434-68, <i>Standard Test Method for Permeability of Granular Soils (Constant Head)</i> .								
ASTM D2937, <i>Standard Test Method for Density of Soil in Place by Drive-Cylinder Method</i> .								
ASTM D5084-03, <i>Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter</i> .								

Table 2-16. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-H-6

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
CAS No.	=	Chemical Abstracts Service number			N/A	=	not applicable	
dpm	=	disintegrations per minute			NV	=	no value	
GC	=	gas chromatography			PCB	=	polychlorinated biphenyl	
IC	=	ion chromatography			RESRAD	=	RESidual RADioactivity (dose model)	
ICP	=	inductively coupled plasma			TBD	=	to be determined	
LSC	=	liquid scintillation counter			UKPA	=	total uranium by kinetic phosphorescence analysis	
MS	=	mass spectroscopy			WAC	=	<i>Washington Administrative Code</i>	

Table 2-17. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 1607-H4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Field Measurements ^d								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	___ ^e
12587-46-1	Gross alpha	100 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	___ ^e
12587-47-2	Gross beta	5,000 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	___ ^e
Performance Requirements for Laboratory Measurements (Radiological)								
10045-97-3	Cesium-137 ^f	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	Gamma energy analysis	≤30 ^g	70-130 ^g
10198-40-0	Cobalt-60 ^f	0.5 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			

Table 2-17. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 1607-H4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
—	Uranium-233/234 ^h	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g	Isotopic – Uranium	≤30 ^g	70-130 ^g
15117-96-1	Uranium-235 ⁱ	0.5 pCi/g ^j	0.61 pCi/g	0.182 pCi/G	0.185 pCi/g			
—	Uranium-238 ^h	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g	Strontium-90	≤30 ^g	70-130 ^g
10098-97-2	Strontium-90 ^{f,k}	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g			
14133-76-7	Technetium-99 ^f	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC – Technetium-99	≤30 ^g	70-130 ^g
10028-17-8	Tritium ^f	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC – Tritium	≤30 ^g	70-130 ^g
Performance Requirements for Laboratory Measurements (Nonradiological)								
16984-48-8	Fluoride	5 mg/kg	4,800 mg/kg	2,880 mg/kg	5,770 mg/kg	EPA 300.0 (Anions by IC)	≤30 ^l	70-130 ^l
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg			
14797-65-0	Nitrite (as N)	2.5 mg/kg	8,000 mg/kg	4 mg/kg	8 mg/kg			
14808-79-8	Sulfate	5 mg/kg	NV	1,030 mg/kg	2,060 mg/kg			
7440-36-0	Antimony	6 mg/kg ^m	32 mg/kg	5.4 mg/kg	25.3 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30 ^l	70-130 ^l
7440-38-2	Arsenic ⁿ	10 mg/kg	TBD	TBD	TBD			
7440-39-3	Barium	2 mg/kg	16,000 mg/kg	1,650 mg/kg	3,300 mg/kg			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-43-9	Cadmium	0.5 mg/kg ^m	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			

Table 2-17. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 1607-H4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7440-48-4	Cobalt ^o	2 mg/kg	24 mg/kg	15.7 mg/kg	NV			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese ^p	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg ^m	400 mg/kg	5.2 mg/kg	1.04 mg/kg			
7440-22-4	Silver	1 mg/kg ^m	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg ^m	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-62-2	Vanadium	2.5 mg/kg	560 mg/kg	2,240 mg/kg	NV			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			
18540-29-9	Hexavalent chromium ^q	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Hexavalent chromium)	≤30 ^l	70-130 ^l
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 (mercury by cold vapor)	≤30 ^l	70-130 ^l
71-43-2	Benzene	0.005 mg/kg ^j	18.2 mg/kg	0.00448 mg/kg	0.014 mg/kg	EPA 8260 (volatile organic compounds)	≤30 ^r	70-130 ^r
56-23-5	Carbon tetrachloride	0.005 mg/kg ^j	7.69 mg/kg	0.031 mg/kg	0.0046 mg/kg			
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
75-35-4	1,1-Dichloroethene	0.01 mg/kg ^j	1.67 mg/kg	0.0005 mg/kg	0.0008 mg/kg			

Table 2-17. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 1607-H4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
79-01-6	Trichloroethene	0.005 mg/kg ^j	11.2 mg/kg	0.00323 mg/kg	0.0355 mg/kg	EPA 8310 (polynuclear aromatic hydrocarbons)	≤30 ^f	70-130 ^f
75-01-4	Vinyl Chloride	0.01 mg/kg ^j	0.667 mg/kg	0.00018 mg/kg	0.0252 mg/kg			
83-32-9	Acenaphthene	0.1 mg/kg	4,800 mg/kg	97.9 mg/kg	131 mg/kg			
120-12-7	Anthracene	0.015 mg/kg	24,000 mg/kg	1,140 mg/kg	9,100 mg/kg			
56-55-3	Benzo(a) anthracene	0.015 mg/kg	1.37 mg/kg	0.856 mg/kg	0.04 mg/kg			
50-32-8	Benzo(a) pyrene	0.015 mg/kg	0.137 mg/kg	2.33 mg/kg	0.109 mg/kg			
205-99-2	Benzo(b) fluoranthene	0.015 mg/kg	1.37 mg/kg	2.95 mg/kg	0.138 mg/kg			
207-08-9	Benzo(k) fluoranthene	0.015 mg/kg	1.37 mg/kg	21.5 mg/kg	0.138 mg/kg			
191-24-2	Benzo(ghi)perylene	0.03 mg/kg	2,400 mg/kg	25,700 mg/kg	7.070 mg/kg			
218-01-9	Chrysene	0.1 mg/kg ^j	1.37 mg/kg	9.56 mg/kg	0.0446 mg/kg			
53-70-3	Dibenz[a,h] anthracene	0.03 mg/kg	1.37 mg/kg	4.29 mg/kg	0.2 mg/kg			
206-44-0	Fluoranthene	0.05 mg/kg	3,200 mg/kg	631 mg/kg	178 mg/kg			
86-73-7	Fluorene	0.03 mg/kg	32,000 mg/kg	101 mg/kg	411 mg/kg			

Table 2-17. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 1607-H4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
193-39-5	Indeno(1,2,3-cd) pyrene	0.03 mg/kg	1.37 mg/kg	8.33 mg/kg	0.389 mg/kg			
85-01-8	Phenanthrene	0.05 mg/kg	24,000 mg/kg	1,140 mg/kg	9,100 mg/kg			
129-00-0	Pyrene	0.05 mg/kg	2,400 mg/kg	655 mg/kg	2,620 mg/kg			
86-74-8	Carbazole	0.33 mg/kg ^j	50 mg/kg	0.314 mg/kg	NV	EPA 8270 (semivolatile organic compounds)	≤30 ^r	70-130 ^r
72-54-8	4,4'-DDD	0.0033 mg/kg ^j	4.17 mg/kg	0.335 mg/kg	0.000464 mg/kg	EPA 8081 (pesticides)	≤30 ^r	70-130 ^r
72-55-9	4,4'-DDE	0.0033 mg/kg ^j	2.94 mg/kg	0.446 mg/kg	0.00123 mg/kg			
5103-74-2	gamma-Chlordane	0.0165 mg/kg ^j	2.86 mg/kg	2.06 mg/kg	0.00117 mg/kg			
7440-61-1	Uranium (total) ^s	1 mg/kg	240 mg/kg	3.21 mg/kg	3.21 mg/kg	UKPA or via isotopic	≤30 ^l	70-130 ^l
7440-38-2	Arsenic	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^l	70-130 ^l
7440-39-3	Barium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^l	70-130 ^l
7440-43-9	Cadmium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^l	70-130 ^l
7440-47-3	Chromium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^l	70-130 ^l
18540-29-9	Hexavalent chromium	3.7 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 7196	≤30 ^l	70-130 ^l
7439-92-1	Lead	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^l	70-130 ^l

Table 2-17. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 1607-H4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7440-22-4	Silver	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^l	70-130 ^l
7782-49-2	Selenium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^l	70-130 ^l
Performance Requirements for Physical Properties								
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937	N/A	N/A

Notes:

- Unless otherwise noted, Preliminary Cleanup Goals are established in WAC 173-340, "Model Toxics Control Act – Cleanup," 2007.
- Value includes a groundwater-to-river dilution attenuation factor of 2 based on the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE/RL-96-17, Rev. 6). A task is included in the *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* (DOE/RL-2008-46) to evaluate the appropriate dilution attenuation factor. Other considerations for analysis include WAC 173-340-730 (6)(b) (2007).
- Equivalent methods may be substituted. For EPA Method 300.0, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*. For EPA Method 200.8, see EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.
- Soils will be logged with a neutron moisture tool and the high resolution, spectral gamma ray logging system. Geologic samples will also be logged. Vadose zone soil samples will be field-screened for gross alpha, gross beta, and gross gamma activities. Aquifer sediment samples will be field-screened for gross gamma activity.

Table 2-17. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 1607-H4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
e.	Field measurements have no specific QC requirement for accuracy except to perform checks to verify manufacturer's expected performance.							
f.	The groundwater protection and river protection preliminary cleanup goal values for cesium-137, cobalt-60, technetium-99, tritium, and strontium-90 were established in DOE/RL-96-17, <i>Remedial Design Report/Remedial Action Work Plan for the 100 Area</i> , Revision 6.							
g.	Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.							
h.	The Uranium-233/234 and Uranium-238 groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site Background.							
i.	The Uranium-235 groundwater and river protection preliminary cleanup goal values are based on the recommended daily limit.							
j.	Calculated cleanup goals are less than established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.							
k.	Strontium-90 will be assessed as total radioactive strontium.							
l.	Accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.							
m.	To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if estimated quantitation limits are met.							
n.	The preliminary cleanup goal value for arsenic will be re-evaluated as described in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i> .							
o.	Cobalt groundwater and river protection preliminary cleanup goal values are based on Hanford Site background values.							
p.	The manganese groundwater and river protection preliminary cleanup goal values are not risk based. They are based on Hanford site background.							
q.	A task is included in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i> to re-evaluate hexavalent chromium cleanup levels.							
r.	Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control limits, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Methods 8260 and 8270.							
s.	The uranium groundwater and river protection preliminary clean goal values are not risk-based. The values are based on Hanford Site background.							
ASTM D422-63, <i>Standard Test Method for Particle-Size Analysis of Soils</i> .								
ASTM D2216-05, <i>Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass</i> .								
ASTM D2434-68, <i>Standard Test Method for Permeability of Granular Soils (Constant Head)</i> .								
ASTM D2937, <i>Standard Test Method for Density of Soil in Place by Drive-Cylinder Method</i> .								

Table 2-17. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 1607-H4

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
ASTM D5084-03, <i>Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter</i> .								
4,4'-DDD	= Dichlorodiphenyldichloroethane			MS	= mass spectroscopy			
4,4'-DDE	= Dichlorodiphenyldichloroethylene			N/A	= not applicable			
CAS No.	= Chemical Abstracts Service number			NV	= no value			
dpm	= disintegrations per minute			RESRAD	= RESidual RADioactivity (dose model)			
IC	= ion chromatography			TBD	= to be determined			
ICP	= inductively coupled plasma			UKPA	= total uranium by kinetic phosphorescence analysis			
LSC	= liquid scintillation counter			WAC	= <i>Washington Administrative Code</i>			

Table 2-18. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from Groundwater Wells During Drilling

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Field Measurements ^d								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	— ^e
12587-46-1	Gross alpha	100 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e
12587-47-2	Gross beta	5,000 dpm/100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	— ^e

Table 2-18. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from Groundwater Wells During Drilling

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Laboratory Measurements (Radiological)								
10045-97-3	Cesium-137 ^f	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	Gamma energy analysis	≤30 ^g	70-130 ^g
10198-40-0	Cobalt-60 ^f	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV ^h	NV ^h			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV ^h	NV ^h			
10098-97-2	Strontium-90 ^{f,i}	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30 ^g	70-130 ^g
14133-76-7	Technetium-99 ^f	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC – Technetium-99	≤30 ^g	70-130 ^g
10028-17-8	Tritium ^f	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC – Tritium	≤30 ^g	70-130 ^g
Performance Requirements for Laboratory Measurements (Nonradiological)								
16984-48-8	Fluoride	5 mg/kg	4,800 mg/kg	2,880 mg/kg	5,770 mg/kg	EPA 300.0 (Anions by IC)	≤30 ^j	70-130 ^j
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg			
14797-65-0	Nitrite (as N)	2.5 mg/kg	8,000 mg/kg	4 mg/kg	8 mg/kg			
14808-79-8	Sulfate	5 mg/kg	NV	1,030 mg/kg	2,060 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30 ^j	70-130 ^j
7440-36-0	Antimony	6 mg/kg ^k	32 mg/kg	5.4 mg/kg	25.3 mg/kg			
7440-38-2	Arsenic ^l	10 mg/kg	TBD	TBD	TBD			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-43-9	Cadmium	0.5 mg/kg ^k	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-48-4	Cobalt ^m	2 mg/kg	24 mg/kg	15.7 mg/kg	NV			

Table 2-18. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from Groundwater Wells During Drilling

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese ⁿ	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg ^k	400 mg/kg	5.2 mg/kg	1.04 mg/kg			
7440-22-4	Silver	1 mg/kg ^k	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg ^k	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-62-2	Vanadium	2.5 mg/kg	560 mg/kg	2,240 mg/kg	NV			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			
18540-29-9	Hexavalent chromium ^o	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Hexavalent chromium)	≤30 ^j	70-130 ^j
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 (mercury by cold vapor)	≤30 ^j	70-130 ^j
71-43-2	Benzene	0.005 mg/kg ^p	18.2 mg/kg	0.00448 mg/kg	0.014 mg/kg	EPA 8260 (volatile organic compounds)	≤30 ^q	70-130 ^q
56-23-5	Carbon tetrachloride	0.005 mg/kg ^p	7.69 mg/kg	0.031 mg/kg	0.0046 mg/kg			
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
75-35-4	1,1-Dichloroethene	0.01 mg/kg ^p	1.67 mg/kg	0.0005 mg/kg	0.0008 mg/kg			
79-01-6	Trichloroethene	0.005 mg/kg ^p	11.2 mg/kg	0.00323 mg/kg	0.0355 mg/kg			
75-01-4	Vinyl Chloride	0.01 mg/kg ^p	0.667 mg/kg	0.00018 mg/kg	0.0252 mg/kg			

Table 2-18. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from Groundwater Wells During Drilling

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
7440-61-1	Uranium (total) ^f	1 mg/kg	240 mg/kg	3.21 mg/kg	3.21 mg/kg	UKPA or via isotopic	≤30 ^j	70-130 ^j
7440-38-2	Arsenic	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^j	70-130 ^j
7440-39-3	Barium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^j	70-130 ^j
7440-43-9	Cadmium	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^j	70-130 ^j
7440-47-3	Chromium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^j	70-130 ^j
18540-29-9	Hexavalent chromium	3.7 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 7196	≤30 ^j	70-130 ^j
7439-92-1	Lead	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^j	70-130 ^j
7440-22-4	Silver	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^j	70-130 ^j
7782-49-2	Selenium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^j	70-130 ^j
—	Distribution coefficient for metals	N/A	N/A	N/A	N/A	1:1 water extract followed by SW-846 Method 6010, 6020, 7196, 7470, or EPA 200.8	N/A	N/A

Table 2-18. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from Groundwater Wells During Drilling

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
Performance Requirements for Physical Properties								
—	Grain size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937	N/A	N/A

Notes:

- Unless otherwise noted, Preliminary Cleanup Goals are established in WAC 173-340, "Model Toxics Control Act – Cleanup," 2007.
- Value includes a groundwater-to-river dilution attenuation factor of 2 based on the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE/RL-96-17, Rev. 6). A task is included in the *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* (DOE/RL-2008-46) to evaluate the appropriate dilution attenuation factor. Other considerations for analysis include WAC 173-340-730 (6)(b) (2007).
- Equivalent methods may be substituted. For EPA Method 300.0, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*. For EPA Method 200.8, see EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.
- Borehole will be logged with a neutron moisture tool and the high resolution, spectral gamma ray logging system. Geologic samples will also be logged. Vadose zone soil samples will be field-screened for gross alpha, gross beta, and gross gamma activities. Aquifer sediment samples will be field-screened for gross gamma activity.
- Field measurements have no specific QC requirement except to perform checks to verify manufacturer's expected performance.
- The groundwater protection and river protection preliminary cleanup goal values for cesium-137, cobalt-60, technetium-99, tritium, and strontium-90 were established in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Revision 6.

Table 2-18. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from Groundwater Wells During Drilling

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
<p>g. Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.</p> <p>h. Generic RESRAD modeling reported in DOE/RL-96-17, <i>Remedial Design Report/Remedial Action Work Plan for the 100 Area</i>, predicts the contaminant will not reach groundwater within 1,000 years; however, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.</p> <p>i. Strontium-90 will be assessed as total radioactive strontium.</p> <p>j. Accuracy criteria specified is for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples is also performed. The precision criteria shown is for batch laboratory replicate matrix spike or replicate sample RPDs.</p> <p>k. To meet or approach calculated cleanup goals, laboratories must use axial-based (“trace”) ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if estimated quantitation limits are met.</p> <p>l. The preliminary cleanup goal value for arsenic will be re-evaluated as described in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i>.</p> <p>m. Cobalt groundwater and river protection preliminary cleanup goal values are based on Hanford Site background values.</p> <p>n. The manganese groundwater and river protection preliminary cleanup goal values are not risk based. They based on Hanford site background.</p> <p>o. A task is included in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i> to re-evaluate hexavalent chromium cleanup levels.</p> <p>p. Calculated cleanup goals are less than established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.</p> <p>q. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control limits, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Method 8260.</p> <p>r. The uranium groundwater and river protection preliminary clean goal values are not risk-based. The values are based on Hanford Site background.</p> <p>ASTM D422-63, <i>Standard Test Method for Particle-Size Analysis of Soils</i>.</p> <p>ASTM D2216-05, <i>Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass</i>.</p> <p>ASTM D2434-68, <i>Standard Test Method for Permeability of Granular Soils (Constant Head)</i>.</p> <p>ASTM D2937, <i>Standard Test Method for Density of Soil in Place by Drive-Cylinder Method</i>.</p> <p>ASTM D5084-03, <i>Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter</i>.</p>								

Table 2-18. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from Groundwater Wells During Drilling

CAS No.	Analyte	Estimated Quantitation Limit	Preliminary Cleanup Goals ^a			Analytical Method ^c	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection ^b			
CAS No.	=	Chemical Abstracts Service number			N/A	=	not applicable	
dpm	=	disintegrations per minute			NV	=	no value	
IC	=	ion chromatography			RESRAD	=	RESidual RADioactivity (dose model)	
ICP	=	inductively coupled plasma			TBD	=	to be determined	
LSC	=	liquid scintillation counter			UKPA	=	total uranium by kinetic phosphorescence analysis	
MS	=	mass spectroscopy			WAC	=	<i>Washington Administrative Code</i>	

Table 2-19. Analytical Performance Requirements for 100-D/H Operable Unit Water Samples

CAS #	Analyte	Analytical Method ^a	Estimated Quantitation Limit ^b	Precision Requirement (%)	Accuracy Requirement (%)	Background ^c	Action Level	Action Level Basis
Performance Requirements for Field Measurements								
—	Oxidation reduction potential	REDOX PROBE	N/A	— ^d	— ^d	NV	N/A	N/A
—	pH measurement	PROBE	0.5 pH unit	— ^d	— ^d	NV	N/A	N/A
—	Specific conductance	PROBE	1 μ S/cm	— ^d	— ^d	NV	N/A	N/A
—	Temperature	PROBE	—	— ^d	— ^d	NV	N/A	N/A
—	Dissolved oxygen	PROBE	—	— ^d	— ^d	NV	N/A	N/A
—	Turbidity	PROBE	0.1 NTU	— ^d	— ^d	NV	N/A	N/A

Table 2-19. Analytical Performance Requirements for 100-D/H Operable Unit Water Samples

CAS #	Analyte	Analytical Method ^a	Estimated Quantitation Limit ^b	Precision Requirement (%)	Accuracy Requirement (%)	Background ^c	Action Level	Action Level Basis
Performance Requirements for Laboratory Measurements (Radiological)								
12587-46-1	Gross alpha	GPC	3 pCi/L	≤30 ^e	70-130 ^e	2.62 pCi/L	15 pCi/L	Federal MCL
12587-47-2	Gross beta	GPC	4 pCi/L	≤30 ^e	70-130 ^e	8.71 pCi/L	N/A	4 mrem/year Federal MCL
10045-97-3	Cesium-137	GEA	15 pCi/L	≤30 ^e	70-130 ^e	3.30 pCi/L	200 pCi/L	Federal MCL
10198-40-0	Cobalt-60	GEA	25 pCi/L	≤30 ^e	70-130 ^e	4.96 pCi/L	100 pCi/L	Federal MCL
14683-23-9	Europium-152	GEA	50 pCi/L	≤30 ^e	70-130 ^e	NV	200 pCi/L	Federal MCL
15585-10-1	Europium-154	GEA	50 pCi/L	≤30 ^e	70-130 ^e	3.06 pCi/L	60 pCi/L	Federal MCL
10098-97-2	Strontium-90 ^f	Strontium-90	2 pCi/L	≤30 ^e	70-130 ^e	1.03 pCi/L	8 pCi/L	40 CFR 141.66
14133-76-7	Technetium-99	LSC – Technetium-99	15 pCi/L	≤30 ^e	70-130 ^e	0.83 pCi/L	900 pCi/L	40 CFR 141.66
10028-17-8	Tritium	LSC –Tritium	400 pCi/L	≤30 ^e	70-130 ^e	167 pCi/L	20,000 pCi/L	40 CFR 141.66
Performance Requirements for Laboratory Measurements (Nonradiological)								
7440-36-0	Antimony	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	5 µg/L	≤20 ^g	80-120 ^g	62.29 µg/L	5.6 µg/L	Human Health for the Consumption of Water + Organism
7440-38-2	Arsenic	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	4 µg/L ^{hi}	≤20 ^g	80-120 ^g	7.69 µg/L	0.018 µg/L	Human Health for the Consumption of Water + Organism
7440-41-7	Beryllium	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	2 µg/L	≤20 ^g	80-120 ^g	0.916 µg/L	4.0 µg/L	40 CFR 141.62
7440-43-9	Cadmium	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	2 µg/L ^{hi}	≤20 ^g	80-120 ^g	0.916 µg/L	0.25 µg/L	Freshwater CCC

Table 2-19. Analytical Performance Requirements for 100-D/H Operable Unit Water Samples

CAS #	Analyte	Analytical Method ^a	Estimated Quantitation Limit ^b	Precision Requirement (%)	Accuracy Requirement (%)	Background ^c	Action Level	Action Level Basis
7440-47-3	Chromium	EPA 6010 (ICP metals)	10 µg/L	≤20 ^g	80-120 ^g	3.29 µg/L	74 µg/L	Freshwater CCC
7440-48-4	Cobalt	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	4 µg/L	≤20 ^g	80-120 ^g	0.897 µg/L	4.8 µg/L	WAC 173-340-720(4) (b)(iii)(A) and (B)
7440-50-8	Copper	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	8 µg/L	≤20 ^g	80-120 ^g	1.00 µg/L	9 µg/L	Freshwater CCC
57-12-5	Cyanide ^{jk}	EPA 9012	5 µg/L	≤20 ^g	80-120 ^g	8.41 µg/L	200 µg/L	Federal MCL
18540-29-9	Hexavalent chromium	EPA 7196 (Hexavalent chromium)	10 µg/L	≤20 ^g	80-120 ^g	NV	10 µg/L	WAC 173-201A
7439-92-1	Lead	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	2 µg/L	≤20 ^g	80-120 ^g	2.06 µg/L	2.1 µg/L	WAC 173-201A
7439-96-5	Manganese	EPA 6010 (ICP metals)	5 µg/L	≤20 ^g	80-120 ^g	43.7 µg/L	50 µg/L	40 CFR 143.3
7439-97-6	Mercury	EPA 200.8	0.5 µg/L ^h	≤20 ^g	80-120 ^g	0.002 µg/L	0.05 µg/L ^b	WAC 173-201A
7440-02-0	Nickel	EPA 6010 (ICP metals)	40 µg/L	≤20 ^g	80-120 ^g	2.91 µg/L	52 µg/L	Freshwater CCC
7782-49-2	Selenium	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	4 µg/L	≤20 ^g	80-120 ^g	12.0 µg/L	5 µg/L	Freshwater CCC
7440-22-4	Silver	ICP Metals - 6010	10 µg/L ^{hi}	≤20 ^g	80-120 ^g	7.19 µg/L	5 µg/L ^b	WAC 173-201A
7440-28-0	Thallium	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	2 µg/L ^{hi}	≤20 ^g	80-120 ^g	1.83 µg/L	0.24 µg/L	Human Health for the Consumption of Water + Organism

Table 2-19. Analytical Performance Requirements for 100-D/H Operable Unit Water Samples

CAS #	Analyte	Analytical Method ^a	Estimated Quantitation Limit ^b	Precision Requirement (%)	Accuracy Requirement (%)	Background ^c	Action Level	Action Level Basis
7440-61-1	Uranium	Total uranium (chemical)	1 µg/L	≤20 ^g	80-120 ^g	9.64 µg/L	30 µg/L	40 CFR 141.62
7440-62-2	Vanadium	EPA 6010 (ICP metals)	25 µg/L	≤20 ^g	80-120 ^g	11.9 µg/L	112 µg/L	WAC 173-340-720(4)(b)(iii)(A) and (B)
7440-66-6	Zinc	EPA 6010 (ICP metals)	10 µg/L	≤20 ^g	80-120 ^g	50.0 µg/L	91 µg/L	WAC 173-201A
75-35-4	1,1-Dichloroethene	EPA 8260 (VOCs)	2 µg/L ⁱ	≤20 ^l	80-120 ^l	NV	1 µg/L ^b	WAC 173-340-720(4)(b)(iii)(A) and (B)
71-43-2	Benzene	EPA 8260 (VOCs)	1.5 µg/L ⁱ	≤20 ^l	80-120 ^l	NV	1 µg/L ^b	WAC 173-340-720(4)(b)(iii)(A) and (B)
56-23-5	Carbon tetrachloride	EPA 8260 (VOCs)	1 µg/L	≤20 ^l	80-120 ^l	NV	1 µg/L ^b	Human Health for the Consumption of Water + Organism
67-66-3	Chloroform	EPA 8260 (VOCs)	5 µg/L	≤20 ^l	80-120 ^l	NV	5.7 µg/L	Human Health for the Consumption of Water + Organism
79-01-6	Trichloroethene	EPA 8260 (VOCs)	1 µg/L	≤20 ^l	80-120 ^l	NV	1 µg/L ^b	WAC 173-340-720(4)(b)(iii)(A) and (B)
75-01-4	Vinyl Chloride	EPA 8260 (VOCs)	5 µg/L	≤20 ^l	80-120 ^l	NV	1 µg/L ^b	Human Health for the Consumption of Water + Organism
16984-48-8	Fluoride	EPA 300.0 (anions by IC)	500 µg/L	≤20 ^g	80-120 ^g	460 µg/L	960 µg/L	WAC 173-340-720(4)(b)(iii)(A) and (B)
14797-55-8	Nitrate (as N) ^m	EPA 300.0 (Anions by IC)	250 µg/L	≤20 ^g	80-120 ^g	6,072 µg/L	10,000 µg/L	40 CFR 141.62

Table 2-19. Analytical Performance Requirements for 100-D/H Operable Unit Water Samples

CAS #	Analyte	Analytical Method ^a	Estimated Quantitation Limit ^b	Precision Requirement (%)	Accuracy Requirement (%)	Background ^c	Action Level	Action Level Basis
14797-65-0	Nitrite (as N) ⁿ	EPA 300.0 (Anions by IC)	250 µg/L	≤20 ^g	80-120 ^g	28.5 µg/L	1,000 µg/L	40 CFR 141.62
14808-79-8	Sulfate	EPA 300.0 (Anions by IC)	500 µg/L	≤20 ^g	80-120 ^g	47,014 µg/L	250,000 µg/L	40 CFR 143.3
N/A	Pesticides ^{ok}	EPA 8081	0.5 to 5 µg/L	≤20 ^l	80-120 ^l	NV	Compound-specific	Compound-Specific
N/A	PCBs ^{pk}	EPA 1668A	0.02 µg/L	≤20 ^l	80-120 ^l	NV	1E-04 to 1.8E-02 µg/L	Aroclor-specific
N/A	PCBs ^{qk}	EPA 8082	5 µg/L	≤20 ^l	80-120 ^l	NV	1E-04 to 1.8E-02 µg/L	Aroclor-specific
N/A	Polynuclear aromatic hydrocarbons ^{rk}	EPA 8310	0.5 to 5 µg/L	≤20 ^l	80-120 ^l	NV	2.8E-03 to 2.4E-03 µg/L	Compound-specific
N/A	SVOCs ^{sk}	EPA 8270	10 to 50 µg/L	≤20 ^l	80-120 ^l	NV	Compound-specific	Compound-specific

Notes:

- Equivalent methods may be substituted. For EPA Method 300.0, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*. For EPA Method 200.8, see EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*. Tentatively identified compounds will be reported for Methods SW-846 8260 and 8270.
- Estimated quantitation limit equal to 5 to 10 times the MDL (SW-846). MDLs are listed in DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*, Table C-30. When the action level is less than the MDL, the action level defaults to the MDL.
- Background values for radionuclides, total metals, and anions are the 90th percentile values from Table 5-2 (if no value listed, Table 5-1 value used) of DOE/RL-96-61, Rev 0, *Hanford Site Background: Part 3: Groundwater Background*. Table 5-1 values were used for cesium-137, cobalt-60, europium-154, europium-155, technetium-99, antimony, silver, and thallium. The background values in Table 5-2 were derived from samples collected and analyzed for the express purpose of establishing the range of background compositions in the upper portion of the unconfined aquifer. To accomplish this, analytical methods were selected to achieve lower detection limits than commonly realized employing conventional analytical techniques.
- Field measurements have no specific quality control requirement except to perform checks to verify manufacturer's expected performance.
- Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for GEA, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.
- Strontium-90 will be assessed as total radioactive strontium.

Table 2-19. Analytical Performance Requirements for 100-D/H Operable Unit Water Samples

CAS #	Analyte	Analytical Method ^a	Estimated Quantitation Limit ^b	Precision Requirement (%)	Accuracy Requirement (%)	Background ^c	Action Level	Action Level Basis
g. Accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples is also performed. The precision criteria shown is for batch laboratory replicate matrix spike or replicate sample relative percent differences.								
h. To meet or approach calculated action levels, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if estimated quantitation limits are met.								
i. Action levels are less than established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.								
j. Cyanide (Method 9012) – this method will be performed only at monitoring well 199-H4-3 for the low-river and high-river stage events.								
k. If a validated detection is obtained, sample collection and analysis for this method at the well will be performed for all subsequent sample events. If there is no validated detection for an analyte or method from the initial scheduled event(s) at the well, that analyte and/or method will be dropped from the analytical suite for the well for subsequent sampling events.								
l. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control limits, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Methods 8260 and 8270.								
m. The background concentration listed was determined by converting the Nitrate background value of 26,871 µg/L (DOE/RL-96-61, Rev. 0) to Nitrate as N. The conversion was achieved by application of a 0.226 conversion factor to the Nitrate value (i.e., 0.226 times Nitrate concentration = Nitrate as N concentration).								
n. The background concentration listed was determined by converting the Nitrite background value of 93.7 µg/L (DOE/RL-96-61, Rev. 0) to Nitrite as N. The conversion was achieved by application of a 0.304 conversion factor to the Nitrite value (i.e., 0.226 times Nitrite concentration = Nitrite as N concentration).								
o. Pesticides (Method 8081) - this method will be performed only at monitoring wells 199-D5-15 and 199-D8-71 for the low-river stage event and at well 199-D8-71 for the high-river stage event. See Appendix A for a list of constituents to be reported, with corresponding estimated quantitation limits, and precision and accuracy requirements.								
p. PCBs (Method 1668A) - this method will be performed only at six selected monitoring wells (199-D8-71, 199-D8-55, 199-D5-15, 199-H4-13, 199-H4-48, 199-H4-10) included in the network for the low-river stage event and for two selected monitoring wells (199-D8-55 and 199-D8-71) for the high river stage event. See Appendix A for a list of constituents to be reported, with corresponding estimated quantitation limits, and precision and accuracy requirements.								
q. PCBs (Method 8082) - this method will be performed only at sixteen selected monitoring wells (199-H4-10, 199-H4-13, 199-H4-48, 199-H4-45, 199-H4-11, 199-H4-16, 199-H4-3, 199-H3-2A, 199-D5-99, 199-D5-17, 199-D5-15, 199-D8-88, 199-D8-55, 199-D8-71, 199-D5-13, 199-D4-84) included in the network for the low-river stage event and five selected monitoring wells (199-H4-3, 199-H4-45, 199-H4-11, 199-D8-55, and 199-D8-71) for the high-river stage event. See Appendix A for a list of constituents to be reported, with corresponding estimated quantitation limits, and precision and accuracy requirements.								
r. Polynuclear aromatic hydrocarbons (Method 8310) - this method will be performed only at sixteen selected monitoring wells (199-H4-10, 199-H4-13, 199-H4-48, 199-H4-45, 199-H4-11, 199-H4-16, 199-H4-3, 199-H3-2A, 199-D5-99, 199-D5-17, 199-D5-15, 199-D8-88, 199-D8-55, 199-D8-71, 199-D5-13, 199-D4-84) included in the network for the low-river stage event and five selected monitoring wells (199-H4-3, 199-H4-45, 199-H4-11, 199-D8-55, and 199-D8-71) for the high-river stage event. See Appendix A for a list of constituents to be reported, with corresponding estimated quantitation limits, and precision and accuracy requirements.								

Table 2-19. Analytical Performance Requirements for 100-D/H Operable Unit Water Samples

CAS #	Analyte	Analytical Method ^a	Estimated Quantitation Limit ^b	Precision Requirement (%)	Accuracy Requirement (%)	Background ^c	Action Level	Action Level Basis
s. SVOCs (Method 8270)- this method will be performed at sixteen selected monitoring wells (199-H4-10, 199-H4-13, 199-H4-48, 199-H4-45, 199-H4-11, 199-H4-16, 199-H4-3, 199-H3-2A, 199-D5-99, 199-D5-17, 199-D5-15, 199-D8-88, 199-D8-55, 199-D8-71, 199-D5-13, 199-D4-84) included in the network for the low-river stage event and five selected monitoring wells (199-H4-3, 199-H4-45, 199-H4-11, 199-D8-55, and 199-D8-71) for the high-river stage event. See Appendix A for a list of constituents to be reported, with corresponding estimated quantitation limits, and precision and accuracy requirements.								
40 CFR 141.62, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels for Inorganic Contaminants."								
40 CFR 141.66, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels for Radionuclides."								
40 CFR 143.3, "National Secondary Drinking Water Regulations," "Secondary Maximum Contaminant Levels."								
EPA-600/4-79-020, <i>Methods for Chemical Analysis of Water and Wastes</i> .								
EPA-600/R-94-111, <i>Methods for the Determination of Metals in Environmental Samples, Supplement 1</i> .								
SW-846, 2007, <i>Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B</i> .								
WAC 173-340-720(4), "Model Toxics Control Act—Cleanup," "Ground Water Cleanup Standards," "Method B Cleanup Levels for Potable Ground Water."								
WAC 173-201A, "Water Quality Standards for Surface Waters of the State of Washington."								
CAS No. = Chemical Abstracts Service number				MDL = method detection limit				
CCC = criterion continuous concentration				MS = mass spectroscopy				
GEA = gamma energy analysis				N/A = not applicable				
GPC = gas proportional counter				NV = no value				
IC = ion chromatography				PCB = polychlorinated biphenyl				
ICP = inductively coupled plasma				SVOC = semivolatile organic compound				
LSC = liquid scintillation counting/counter				VOC = volatile organic compound				
MCL = maximum contaminant level				WAC = <i>Washington Administrative Code</i>				

2.1.5 Special Training and Certification

A graded approach is used to ensure workers receive a level of training that is commensurate with responsibilities and complies with applicable DOE orders and government regulations. The sampling lead and drilling lead, in coordination with line management, will ensure that field personnel meet special training requirements.

Typical training requirements or qualifications have been instituted by the primary contractor management team to meet training requirements imposed by the contract, regulations, DOE orders, DOE contractor requirements documents, American National Standards Institute/American Society of Mechanical Engineers, and *Washington Administrative Code* (WAC). For example, the environmental safety and health training program provides workers with the knowledge and skills necessary to execute assigned duties safely. Field personnel typically will have completed the following training before starting work:

- Occupational Safety and Health Administration 40-hour hazardous waste worker training and supervised 24-hour hazardous waste-site experience
- 8-hour hazardous waste worker refresher training (as required)
- Hanford general employee radiation training
- Hanford general employee training
- Radiological worker training

Project-specific safety training, geared specifically to the project and the day's activity, will be provided. Project-specific training includes the following:

- Training requirements or qualifications needed by sampling personnel will be in accordance with QA requirements.
- Samplers are required to have training and/or experience in the type of sampling being performed in the field, soil/aquifer sediment sampling and water sampling.
- The Radiation Protection Program establishes qualification requirements for radiological control technicians. The radiological control technicians assigned to these activities will be qualified through the prescribed training program and will undergo ongoing training and qualification activities.

In addition, pre-job briefings will be performed to evaluate an activity and its hazards by considering many factors, including the following:

- Objective of the activities
- Individual tasks to be performed
- Hazards associated with the planned tasks
- Controls applied to mitigate the hazards
- Environment in which the job will be performed
- Facility where the job will be performed
- Equipment and material required
- Safety procedures applicable to the job

- Training requirements for individuals assigned to perform the work
- Level of management control
- Proximity of emergency contacts

Training records are maintained for each individual in an electronic training record database. The contractor training organization maintains the training records system. Line management will be used to confirm an individual employee's training is appropriate and up-to-date before performing any fieldwork.

2.1.6 Documents and Records

The project lead is responsible for ensuring the current version of the SAP is being used and for providing updates to field personnel. Version control is maintained through the administrative document control process. Before implementation, DOE and the regulatory agency will review and approve changes to the sampling plan that affect the data needs. Information pertinent to sampling and analysis will be recorded in field checklists and bound logbooks in accordance with existing sample collection protocols in accordance with HASQARD (DOE/RL-96-68).

The sampling lead or drilling lead is responsible for ensuring the field instructions are maintained up-to-date and aligned with revisions or other approved changes to the SAP. The sampling lead or drilling lead will ensure that deviations from the SAP or problems encountered in the field are documented appropriately (e.g., in the field logbook, on nonconformance report forms) in accordance with internal corrective action procedures.

The project lead, drilling lead, sampling lead, or designee will be responsible for communicating field corrective action requirements and for ensuring immediate corrective actions are applied to field activities. Table 2-20 presents the change control for this project.

Table 2-20. Change Control for the 100-D/H Operable Unit Project

Type of Change	Action	Documentation
By drilling lead or sampling lead:	No SAP revision necessary	Field logbooks or operational records
<ul style="list-style-type: none"> • Increasing sampling frequency based on field screening results or visual observations 		
By project management:	Revise SAP (can be accomplished with Tri-Party Agreement Change Notice); obtain regulatory approval; distribute plan	Revised plan or approved Tri-Party Agreement Change Notice
<ul style="list-style-type: none"> • Change in target analytes or COPCs • Adding/removing wells • Significant increases or decreases in sampling frequency 		

Logbooks are required for field activities. The logbook must be identified with a unique project name and number. Individuals responsible for logbooks will be listed. Only authorized persons may make entries in logbooks. Logbooks will be signed by the sampling lead, drilling lead, cognizant scientist/engineer, or other responsible individual. Logbooks will be permanently bound, waterproof, and ruled with sequentially numbered pages. Pages will not be removed from logbooks for any reason.

Logbook entries will be made in indelible ink. Corrections will be made by marking the erroneous data through with a single line, entering the correct data, and initialing and dating the changes.

The project lead is responsible for ensuring the project file is properly maintained. The project file will contain the records or references to their storage locations. The project file will include the following, as appropriate:

- Field logbooks or operational records
- Data forms
- Global Positioning System data
- Chain-of-custody forms
- Sample receipt records
- Inspection or assessment reports and corrective action reports
- Interim progress reports
- Final reports
- Forms required by WAC 173-160, “Minimum Standards for Construction and Maintenance of Wells,” and the master drilling contract
- Laboratory data packages
- RI report
- Verification and validation report

The laboratory is responsible for maintaining, and having available upon request, the following:

- Analytical logbooks
- Raw data and QC sample records
- Standard reference material and/or proficiency test sample data
- Instrument calibration information

Records may be stored in either electronic or hard copy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes to ensure accuracy and availability of stored records. Records required by the Tri-Party Agreement will be managed in accordance with the requirements of the Agreement.

2.2 Data Generation and Acquisition

The following sections address data generation and acquisition to ensure the project methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are appropriate and documented.

2.2.1 Sampling Process Design (Experimental Design)

The sampling design is judgmental sampling. In judgmental sampling, sampling unit selection (e.g., the number and location and/or timing of collecting samples) is based on knowledge of the feature or condition under investigation and on professional judgment. Judgmental sampling is distinguished from probability based sampling in that inferences are based on professional judgment, not statistical scientific theory. Therefore, conclusions about the target population are limited and depend entirely on the validity

and accuracy of professional judgment. Probabilistic statements about parameters are not possible. Section 3.5 provides the types, number, and location of samples.

2.2.2 Sampling Methods

Section 3.6 describes the sampling methods. The specific information includes the following:

- Field sampling methods
- Corrective actions for sampling activities (the task lead will be responsible for corrective action)
- Decontamination of sampling equipment
- Radiological field data

2.2.3 Sample Handling and Custody

A sampling and data tracking database is used to track the samples from the point of collection through the laboratory analysis process. Samplers should note any anomalies (e.g., sample appears unusual or sample is sludge) with the samples to prevent batching across similar matrices. If anomalies are found, the samplers should write “DO NOT BATCH” on the chain-of-custody form and inform Sample Management and Reporting.

Laboratory analytical results are entered and maintained in HEIS. The HEIS sample numbers are issued to the sampling organization for the project. Each chemical, radiological, and physical properties sample is identified and labeled with a unique HEIS sample number.

Section 3.7 provides the following specific sample handling information:

- Container packaging
- Container labeling
- Sample custody requirements
- Sample transportation

Sample custody during laboratory analysis is addressed in the applicable laboratory standard operating procedures. Laboratory custody procedures will ensure that sample integrity and identification are maintained throughout the analytical process. Storage of samples at the laboratory will be consistent with laboratory instructions prepared by Sample Management and Reporting.

2.2.4 Analytical Methods

Tables 2-3 through 2-19 provide information on analytical methods. These analytical methods are controlled in accordance with the laboratory’s QA plan and the requirements of this QAPjP. The primary contractor or vadose zone contractor, as applicable, participates in overseeing the offsite analytical laboratories to qualify them for performing Hanford Site analytical work.

If the laboratory uses a nonstandard or unapproved method, then the laboratory must provide method validation data to confirm the method is adequate for the intended use of the data. This includes information such as determination of detection limits, quantitation limits, typical recoveries, and analytical precision and bias. In consultation with the laboratory, the project lead, and/or others as appropriate, Sample Management and Reporting can approve changes to analytical methods as long as the method is based upon a nationally recognized (e.g., EPA, ASTM) method, the new method achieves project DQOs as well or better than the replaced method, and the new method is required due to the nature of the sample (e.g., high radioactivity).

Laboratories providing analytical services in support of this SAP will have in place a corrective action program addressing analytical system failures and documents on the effectiveness of corrective actions. Issues affecting analytical results are to be resolved by Sample Management and Reporting in coordination with the project lead.

Batch leach tests will be performed on soil and aquifer sediment samples. Standardized batch leach tests are done using a leach procedure based on ASTM D3987, *Standard Test Method for Shake Extraction of Solid Waste with Water*. The procedure will be preferentially performed using a 2-mm sieve to include the entire sand fraction based on the USDA soil grain size classification scheme, though ASTM recommends using soil screened through 3/8 inch mesh. If insufficient sample mass with less than 2-mm particle diameter is available based on actual field conditions, a 3/8-inch mesh screen will be used instead. Demineralized water, pH adjusted according to EPA's West Coast recommendation, will be used as the leaching liquid. Selected soil samples will be leached at soil to water weight ratios of 1 to 1, 1 to 2.5, and 1 to 5 with one test in each series duplicated. Soil/water mixtures are placed in clean water tight sample containers (extraction vessels) and rotated end over end through the vessel centerline at a rate of about 30 rotations per minute for 18 hours. Following 18 hours of mixing, the soil/water slurry is filtered using a 0.45- μ m filter. The leachate will be analyzed for pH and conductivity. The leachate and untreated soil will be analyzed for metals or other contaminants of interest as identified in Tables 2-3 through 2-18. Metals analysis for leachate and soil digests will be done using Method 6010, 6020, or 200.8 for ICP metals, as applicable (bulk soil will be digested using Method 3050B or 3051 for metals and Method 3060A for hexavalent chromium to prepare for analysis). Separate aliquots of material will be used for bulk soil analysis and leaching. Analytical results are compared between different soil to water ratios and duplicate tests to evaluate repeatability and attainment of equilibrium conditions. Details of the test will be discussed with the laboratory personnel before analysis.

Distribution coefficient values will be established to support modeling needs. Distribution coefficient calculations will be performed using the analytical results from bulk soils analysis and leach testing of soils collected from the same location. The distribution coefficient is calculated as the ratio of contaminant sorbed to soil to the contaminant in solution by the following equation:

$$K_d = \frac{(C_S \times M_S) - (C_L \times V_L)}{M_S} \times \frac{1}{C_L}$$

Where,

C_S = Contaminant concentration in bulk soil matrix prior to leaching (μ g/g)

M_S = Dry mass of soil used for leaching (g)

C_L = Contaminant concentration in leachate (μ g/L)

V_L = Liquid volume used for leaching (L)

Contamination present in pore water within the bulk soil matrix is not analyzed or accounted for separately, as the associated contaminant mass is included within the bulk leachate. Distribution coefficient values are calculated separately for each contaminant and each dilution ratio. The series of calculated values is then qualitatively evaluated to determine if the variation within results is reasonable and explainable.

A minimum of 10 independent samples (e.g., from different locations) will be analyzed by this method.

Grain size (sieve) analysis may be performed as a field procedure or in the laboratory based on ASTM D422-63, *Standard Test Method for Particle Size Analysis of Soils*. Field grain size analysis may be used to select well screens for groundwater wells.

2.2.5 Quality Control

To ensure reliable data are obtained, QC procedures must be followed in the field and laboratory. Field personnel will collect QC samples to evaluate the potential for cross-contamination and to provide information pertinent to field variability. Field QC sampling will require the collection of field duplicates, trip or field transfer blanks, equipment rinsate blanks, and field splits. Laboratory QC samples estimate the precision and bias of the analytical data. Table 2-21 summarizes field and laboratory QC samples. Additional QC samples may be collected if conditions arise.

Table 2-21. Project Quality Control Checks

QC Sample Type	Purpose	Frequency
Field Quality Control		
Full trip blank	Assess contamination from containers or transportation	One per 20 samples, <i>per media sampled</i> .
Field transfer blank	Assess contamination from sampling site	One per day when volatile organic compounds are sampled, <i>per media sampled</i> .
Equipment rinsate blank	Verify adequacy of sampling equipment decontamination	As needed. ^a If only disposable equipment is used or equipment is dedicated to a particular well, then an equipment rinsate blank is not required. Otherwise, 1 per 20 samples, <i>per media sampled</i> .
Field duplicates	Estimate precision, including sampling and analytical variability	One per batch, ^b 20 samples maximum, <i>per media sampled</i> .
Field split	Estimate precision, including sampling, analytical, and inter-laboratory variability	At a minimum, one per analytical method, per media, for analyses performed where detection limit and precision and accuracy criteria have been defined in the Performance Requirements Tables.
Laboratory Quality Control^b		
Method blank	Assess response of an entire laboratory analytical system	One per batch, ^b 20 samples maximum, or as identified by the method guidance, <i>per media sampled</i> .
Matrix spike	Identify analytical (preparation and analysis) bias; possible matrix affect on the analytical method used	When required by the method guidance, one per batch, ^b 20 samples maximum, or as identified by the method guidance, <i>per media sampled</i> .
Matrix duplicate or matrix spike duplicate	Estimate analytical bias and precision	When required by the method guidance, one per batch, ^b 20 samples maximum, or as identified by the method guidance, <i>per media sampled</i> .
Laboratory control samples	Assess method accuracy	One per batch, ^b 20 samples maximum, or as identified by the method guidance, <i>per media sampled</i> .
Surrogates	Estimate recovery or yield	When required by the method guidance, as identified by the method guidance.

Table 2-21. Project Quality Control Checks

QC Sample Type	Purpose	Frequency
Notes:		
a. Whenever a new type of non-dedicated equipment is used, an equipment rinsate blank will be collected every time sampling occurs until it can be shown that less frequent collection of equipment rinsate blanks is adequate to monitor the decontamination procedure for the non-dedicated equipment.		
b. Batching across projects is allowed for similar matrices (e.g., Hanford Site groundwater).		

2.2.5.1 Field QC Samples

The Field QC sample types are discussed within this section.

Full trip blanks are samples prepared by the sampling team before traveling to the sampling site. The preserved bottle set is identical to the set collected in the field, but it is filled with reagent water or silica sand, as appropriate to the primary sample media. The bottles are sealed and transported, unopened, to the field in the same storage container used for samples collected the same day. Full trip blanks are typically analyzed for the same constituents as the samples from the associated sampling event. However, the analytical list for full trip blanks for soil may be limited to volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and total petroleum hydrocarbons (TPH). Full trip blanks are not required for aquifer sediments being analyzed for metals, mercury, and hexavalent chromium.

Field transfer blanks are preserved VOC sample vials filled at the sample collection site with reagent water or silica sand, as appropriate to the primary sample media, transported to the field. The samples are prepared during the sampling to evaluate potential contamination caused by field conditions. After collection, field transfer blank bottles are sealed and placed in the same storage container with the samples from the associated sampling event. Field transfer blank samples are analyzed for VOCs only.

A minimum of one field transfer blank will be collected at each borehole where the samples will undergo VOC analysis. The field transfer blank will consist of reagent water added to clean sample vials at the location where the VOC sample was collected. The field transfer blank will be batched with samples for which VOC analysis is requested.

Equipment rinsate blanks are collected for reused sampling devices to assess the adequacy of the decontamination process. Equipment rinsate blanks will consist of silica sand or reagent water poured over the decontaminated sampling equipment and placed in containers, as identified on the project sampling authorization form. If disposable (e.g., single-use) equipment is used, equipment rinsate blanks will not be required.

For the field blank samples (e.g., full trip blank, field transfer blank, equipment rinsate blank), results greater than two times the method detection limit are identified as suspected contamination. However, for common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the limit is five times the method detection limit. For radiological data, blank results are flagged as suspected contamination if they are greater than two times the total minimum detectable activity.

Field duplicate samples are used to evaluate sample consistency and the precision of field sampling methods. Field duplicates are independent samples collected as close as possible to the same point in space and time. They are two separate samples taken from the same source, stored in separate containers, and analyzed independently.

A minimum of one soil and one aquifer sediment field duplicate will be collected for each day of sampling. The duplicate should be collected generally from an area expected to have some contamination, so valid comparisons between the samples can be made (e.g., at least some of the constituents will be greater than the detection limit). When sampling is performed from a split spoon, VOC samples and VOC duplicate samples are collected directly from the sampler. The remaining soil/aquifer sediment is then composited in a stainless steel mixing bowl. The soil/aquifer sediment sample and duplicate sample are collected from this composited material.

Evaluation of the results can provide an indication of intra-laboratory variability. Evaluation criteria for field duplicate sample results is described in Section 2.2.5.3.

A **field split** is a representative sample from a sampling event sent to a third party laboratory (i.e., reference laboratory). Evaluation of the results can provide an indication of inter-laboratory variability. Field split sample result evaluation criteria are described in Section 2.2.5.3.

2.2.5.2 Laboratory QC Samples

The laboratory QC samples (e.g., method blanks, laboratory control sample/blank spike, matrix spike) are defined for three-digit EPA methods (EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*, and EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*) and four-digit EPA methods (SW-846), and will be run at the frequency specified in the respective reference. Quality control checks outside of control limits will be reflected in the data validation process and during the DQA described in Section 2.4.

2.2.5.3 QC Requirements

If only disposable equipment is used or equipment is dedicated to a particular well, then an equipment rinsate blank is not required. If no VOC samples are collected, then a field transfer blank is not required. Field transfer blanks are not required when simply transferring samples to the field gas chromatograph for analysis.

Only those field duplicate result pairs with at least one result greater than five times the appropriate detection limit or minimum detectable activity are evaluated. Field duplicate sample results must agree within 20 percent, as measured by the relative percent difference, to be acceptable. Unacceptable field duplicate results are flagged with a “Q” qualifier in the HEIS database. Large relative percent differences can be an indication of laboratory performance problems and should be investigated.

Only those field split result pairs with at least one result greater than five times the appropriate detection limit or minimum detectable activity are evaluated. Field split sample results must agree within 20 percent, as measured by the relative percent difference, to be acceptable. Unacceptable field split results are qualified and flagged in the HEIS database, as appropriate. Large relative percent differences can be an indication of inter-laboratory variability and potential laboratory performance problems, and should be investigated.

Table 2-2 presents the precision and accuracy requirements for downhole geophysical logging performed in the field. Tables 2-3 through 2-19 present the acceptance criteria for laboratory duplicate sample, matrix spike sample, matrix spike duplicate sample, and laboratory control sample results for chemical analyses.

Holding time is the elapsed time period between sample collection and analysis, or sample collection to extraction and sample extraction to analysis, as applicable to the method. Exceeding recommended holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Recommended holding times depend on the analytical method, as specified

for three- and four-digit EPA methods (EPA-600/4-79-020; EPA-600/R-94-111; SW-846). Holding times are specified in laboratory contracts. Data associated with exceeded holding times are flagged and qualified in HIES, as appropriate.

Additional QC measures include laboratory audits and participation in nationally based performance evaluation studies. The laboratories participate in national studies such as the EPA-sanctioned water pollution and water supply performance evaluation studies. The Soil and Groundwater Remediation Project periodically audits the analytical laboratories to identify and solve quality problems or to prevent such problems. Audit results are used to improve performance. Summaries of audit results and performance evaluation studies are presented in the annual groundwater monitoring report (e.g., DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*). Failure of QC will be determined and evaluated during data validation and the DQA process. Data will be qualified as appropriate.

2.2.6 Instrument and Equipment Testing, Inspection, and Maintenance

Equipment used for collection, measurement, and testing should meet the applicable standards (e.g., ASTM) or have been evaluated as acceptable and valid in accordance with the procedures, requirements, and specifications. The sampling lead or equivalent will ensure that the data generated from instructions using a software system are backed up and/or downloaded regularly. Software configuration will be acceptance tested before use in the field.

Measurement and testing equipment used in the field or in the laboratory that directly affects the quality of analytical data will be subject to preventive maintenance measures to ensure minimization of measurement system downtime. Laboratories and onsite measurement organizations must maintain and calibrate their equipment. Maintenance requirements (such as documentation of routine maintenance) will be included in the individual laboratory and the onsite organization QA plan or operating procedures, as appropriate. Maintenance of laboratory instruments will be performed in a manner consistent with three- and four-digit EPA methods (EPA-600/4-79-020; EPA-600/R-94-111; SW-846), or with auditable Hanford Site and contractual requirements. Consumables, supplies, and reagents will be reviewed in accordance with SW-846 requirements and will be appropriate for their use.

2.2.7 Instrument and Equipment Calibration and Frequency

Section 3.4 provides specific field equipment calibration information. Analytical laboratory instruments and measuring equipment are calibrated in accordance with the laboratory's QA plan.

2.2.8 Inspection and Acceptance of Supplies and Consumables

Supplies and consumables used in support of sampling and analysis activities will be procured in accordance with internal work requirements and processes described in the contractor acquisition system. Responsibilities and interfaces necessary to ensure items are procured or acquired for the contractor to meet the specific technical and quality requirements must be in place. The procurement system ensures purchased items comply with applicable procurement specifications. Supplies and consumables are checked and accepted by users before use. Supplies and consumables procured by the analytical laboratories are procured, checked, and used in accordance with the laboratories' QA plans.

2.2.9 Non-Direct Measurements

Non-direct measurements include data obtained from sources such as computer databases, programs, literature files, and historical databases. Non-direct measurements will not be evaluated as part of this activity.

2.2.10 Data Management

Sample Management and Reporting, in coordination with the project lead, is responsible for ensuring analytical data are appropriately reviewed, managed, and stored in accordance with the applicable programmatic requirements governing data management procedures. Electronic data access, when appropriate, will be through a database (e.g., HEIS, project-specific database). Where electronic data are not available, hard copies will be provided in accordance with Section 9.6 of the Tri-Party Agreement Action Plan (Ecology et al., 1989b).

Laboratory errors are reported to Sample Management and Reporting routinely. For reported laboratory errors, a sample issue resolution form will be initiated in accordance with contractor procedures. This process is used to document analytical errors and to establish resolution with the project lead. The sample issue resolution forms become a permanent part of the analytical data package for future reference and for records management.

Planning for sample collection and analysis will be in accordance with the programmatic requirements governing fixed-laboratory sample collection activities, as discussed in sampling procedures. If specific procedures do not exist for a particular work evolution, or it is determined additional guidance is needed to complete certain tasks, a work package will be developed to adequately control the activities, as appropriate. Examples of the sampling procedure requirements include activities associated with the following:

- Chain-of-custody/sample analysis requests
- Project and sample identification for sampling services
- Control of certificates of analysis
- Logbooks
- Checklists
- Sample packaging and shipping

When this SAP is implemented, approved work control packages and procedures will be used to document field activities, including radiological and nonradiological measurements. Field activities will be recorded in the field logbook. Examples of the types of documentation for field radiological data include the following:

- Instructions regarding the minimum requirements for documenting radiological controls information in accordance with 10 CFR 835, "Occupational Radiation Protection."
- Instructions for managing the identification, creation, review, approval, storage, transfer, and retrieval of primary contractor radiological records.
- Minimum standards and practices necessary for preparing, performing, and retaining radiological related records.
- Indoctrination of personnel on the development and implementation of sample plans.
- Requirements associated with preparing and transporting regulated material.
- Daily reports of radiological surveys and measurements collected during conduct of field investigation activities. Data will be cross-referenced between laboratory analytical data and radiation measurements to facilitate interpreting the investigation results.

2.3 Assessment and Oversight

The elements included in assessment and oversight address the activities for assessing the effectiveness of project implementation and associated QA/QC activities. The purpose of assessment is to ensure that the QAPjP is implemented as prescribed.

2.3.1 Assessments and Response Actions

Contractor management, regulatory compliance, quality, and/or Health and Safety organizations may conduct random surveillance and assessments to verify compliance with the requirements outlined in this SAP, project work packages, the procedures, and regulatory requirements. Section 2.4 discusses the only planned assessment, a DQA, for the activities identified in this SAP. The results of the DQA will be provided to the project lead.

If circumstances arise in the field dictating the need for additional assessment activities, then additional assessments will be performed. Deficiencies identified by these assessments will be reported in accordance with existing programmatic requirements. The project's line management chain coordinates the corrective actions and/or deficiencies in accordance with the contractor QA program, the corrective action management program, and associated procedures that implement these programs.

Oversight activities in the analytical laboratories, including corrective action management, are conducted in accordance with the laboratories' QA plans. The contractor conducts oversight of offsite analytical laboratories and qualifies the laboratories for performing Hanford Site analytical work.

2.3.2 Reports to Management

Reports to management on data quality issues will be made if these issues are identified. Issues reported by the laboratories are communicated to Sample Management and Reporting, which initiates a sample issue resolution form in accordance with contractor procedures. This process is used to document analytical or sample issues and to establish resolution with the project lead. At the end of the project, a DQA report will be prepared to determine if the type, quality, and quantity of collected data met the quality objectives described in this SAP.

2.4 Data Validation and Usability

The elements under data validation and usability address the QA activities occurring after the data collection phase of the project is completed. Implementation of these elements determines whether the data conform to the specified criteria, thus satisfying the project objectives.

2.4.1 Data Review, Verification, and Validation

The criteria for verification include, but are not limited to, review for completeness (samples were analyzed as requested), use of the correct analytical method or procedure, transcription errors, correct application of dilution factors, appropriate reporting of dry weight versus wet weight, and correct application of conversion factors. Laboratory personnel may perform data verification.

Data validation will be performed to ensure that the data quality goals established during the planning phase have been achieved. Data validation will be in accordance with internal procedures. The criteria for data validation are based on a graded approach. The primary contractor has defined five levels of validation, Level A through Level E. Level A is the lowest level and is the same as verification. Level E is a 100 percent review of data (e.g., calibration data; calculations of representative samples from the dataset). Validation will be performed to contractor Level C, which is a review of the QC data. Level C validation specifically requires verification of deliverables; requested versus reported analyses; and

qualification of the results based on analytical holding times, method blank results, matrix spike/matrix spike duplicate results, surrogate recoveries, duplicate results, and analytical method blank results. Level C validation will be performed on at least 5 percent of the data by matrix and analyte group. Analyte group refers to categories, such as radionuclides, VOCs, SVOCs, polychlorinated biphenyls (PCBs), metals, and anions. The goal is to cover the various analyte groups and matrices during the validation.

Relative to analytical data in sample media, physical data and/or field screening results are of lesser importance in making inferences of risk. Field QA/QC will be reviewed to ensure that physical property data and/or field screening results are usable.

2.4.2 Verification and Validation Methods

Validation activities will be based on EPA functional guidelines. Data validation may be performed by Sample Management and Reporting, and/or by a party independent of both the data collector and the data user. Data validation qualifiers must be compatible with the HEIS database.

When outliers or questionable results are identified, additional data validation will be performed. The additional validation will be performed for up to 5 percent of the statistical outliers and/or questionable data. The additional validation will begin with Level C and may increase to Levels D and E as needed to ensure that data are usable. Level C validation is a review of the QC data, while Levels D and E include review of calibration data and calculations of representative samples from the dataset. Data validation will be documented in data validation reports. An example of questionable data is if the positive detections are greater than the practical quantitation limit or reporting limit in soil/aquifer sediment from a site that should not have exhibited contamination. Similarly, results less than background would not be expected and could trigger a validation inquiry. The determination of data usability will be conducted and documented in a DQA report. Data validation will be documented in data validation reports, which will be included in the project file.

2.4.3 Reconciliation with User Requirements

The DQA process compares completed field sampling activities to those proposed in corresponding sampling documents and provides an evaluation of the resulting data. The purpose of the data evaluation is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet the project data needs. The results of the DQA will be used in interpreting the data and determining if the objectives of this activity have been met. The DQA will be in accordance with EPA/240/B-06/002, *Data Quality Assessment: A Reviewer's Guide*, and EPA/240-B-06/003, *Data Quality Assessment: Statistical Methods for Practitioners*.

2.4.4 Corrective Actions

The responses to data quality defects identified through the DQA process will vary and may be data- or measurement-specific. Some pre-identified corrective actions are identified in Table 2-1.

3 Field Sampling Plan

The following sections provide additional details regarding field-specific sample and data collection requirements.

3.1 Site Background and Objectives

Site background information is contained in Addendum 1. Table 1-2 presents the groundwater COPCs and additional analytes. Tables 2-3 through 2-18 present the soil/aquifer sediment target analytes specific to each site. Section 1.6 of this SAP provides guidance on the implementation schedule. The objective of the field sampling plan is to clearly identify project sampling and analysis activities. The field sampling plan uses the sampling design identified during the systematic planning process and presents the design to identify sampling locations, the total number of samples to be collected, and analyses to be performed.

3.2 Documentation of Field Activities

Logbooks or data forms are required for field activities. Section 2.1.6 provides logbook requirements. Data forms may be used to collect field information. However, the data forms must be referenced in the logbooks and must follow the same requirements as those for logbooks presented below. The following is a summary of information to be recorded in logbooks:

- Purpose of activity
- Day, date, time, weather conditions
- Names, titles, organizations of personnel present
- Deviations from the QAPjP or procedures
- All site activities, including field tests
- Materials quality documentation (e.g., certifications)
- Details of samples collected (preparation, splits, duplicates, matrix spikes, blanks)
- Location and types of samples
- Chain-of-custody details and variances relating to chain-of-custody
- Field measurements
- Field calibrations, surveys, and equipment identification numbers as applicable
- Equipment decontaminated, number of decontaminations, and variations to decontamination procedures
- Equipment failures or breakdowns and descriptions of any corrective actions
- Telephone calls relating to field activities

3.3 Sampling Design

As Section 2.2.1 presents, the sampling design is judgmental sampling.

3.4 Calibration of Field Equipment

The sampling lead is responsible for ensuring that field equipment is calibrated appropriately. Onsite environmental instruments are calibrated in accordance with manufacturer operating instructions, internal work requirements and processes, and/or work packages that provide direction for equipment calibration or verification of accuracy by analytical methods. The results from instrument calibration activities are recorded in logbooks and/or work packages. Hard copy or electronic versions are acceptable.

Calibrations must be performed as follows:

- Before initial use of a field analytical measurement system
- At the frequency recommended by the manufacturer or procedure, or as required by regulations
- Upon failure to meet specified QC criteria

Field instrumentation, calibration, and QA checks will be performed in accordance with the following:

- As specified in its program documentation, Pacific Northwest National Laboratory calibrates radiological field instruments on the Hanford Site.
- Daily calibration checks will be performed and documented for each instrument used to characterize areas under investigation. These checks will be made on standard materials sufficiently like the matrix under consideration for direct comparison of data. Analysis times will be sufficient to establish detection efficiency and resolution.

3.5 Sample Location and Frequency

The purpose of this section is to identify the sampling locations and frequencies and define the sampling and analysis requirements for samples and measurements to be collected. Figure 1-1 shows the approximate location of boreholes, test pits, groundwater monitoring wells, and aquifer tubes described in this SAP. Appendix D presents additional figures providing the locations of planned boreholes, test pits, and groundwater characterization wells to be installed under the scope of this SAP relative to historical limited field investigation wells. The actual locations will be determined based on a field walkdown of current site conditions to avoid Hanford Site National Historic restrictions, roads, and other obstructions.

3.5.1 Vadose Zone Characterization

Samples will be collected from boreholes and planned groundwater monitoring wells to support characterization of the vadose zone and groundwater as outlined in Table 1-1. The vadose zone will be characterized by performing intrusive investigations at 16 waste sites:

- 100-D-4 Trench
- 100-D-12 French Drain
- 116-D-1A Trench
- 116-D-1B Trench
- 116-D-4 Crib
- 116-D-7 Retention Basin
- 116-DR-1&2 Trench
- 116-DR-9 Retention Basin
- 118-D-6 Reactor Fuel Storage Basin
- 116-H-1 Trench

- 116-H-2 Liquid Waste Trench
- 116-H-4 Pluto Crib
- 116-H-6 Solar Evaporation Basin
- 116-H-7 Retention Basin
- 118-H-6 Reactor Fuel Storage Basin
- 1607-H4 Septic Tank and Field

Intrusive investigations consist mainly of collecting and analyzing samples from planned boreholes and trenches (i.e., test pits) in areas of known or suspected contamination. Test pits will be excavated and sampled at the 100-D-4 Trench, 100-D-12 French Drain, 116-D-4 Crib, 116-H-2 Liquid Waste Trench, and 1607-H4 Septic System.

Each new groundwater monitoring well will have deep vadose zone samples collected for vadose zone characterization during installation. These activities are planned to characterize the nature and vertical extent of contamination in the vadose zone beneath waste sites, characterize the physical properties of soil/aquifer sediments, locate potential sources, and verify contaminant distribution coefficients to support modeling and an assessment of risk. The data from the activities will be used to verify the adequacy of interim remedial actions and refine the preliminary conceptual site model for 100-D/H.

The scope of vadose zone characterization efforts includes field screening, collecting and analyzing soil samples from the vadose zone, collecting and analyzing aquifer sediment samples, performing groundwater sampling and analysis, and performing geophysical logging. The general intent of the borehole sampling design is to begin sample collection at the maximum depth of remedial action or bottom of the waste site and periodically to the water table. The sampling frequency will be continuous within 3.1 m (10 ft) of the vadose zone-groundwater interface. Vadose zone samples will be collected according to the sampling scheme shown in Table 3-1. The sampling scheme for each borehole includes collecting soil samples periodically throughout the vadose zone, collecting one sample of aquifer sediments 1.5 m (5 ft) into the water table, and collecting one filtered groundwater sample. The sampling scheme for deep vadose zone samples at groundwater wells includes collecting soil samples periodically above the water table and collecting samples of aquifer sediments within the water table. Additional samples may be collected based on observations made in the field. Soil samples will not be collected during the installation of the aquifer tube sets.

Physical property samples will be collected to provide site-specific values to support modeling efforts. The physical property samples will be collected from lithologies representing major facies and surrounding the Hanford-Ringold contact. The physical property samples will be collected in conjunction with split-spoon sample intervals, where possible.

3.5.1.1 Field Screening

Radiological field screening data, visual observation of lithologies, visual observation of contamination, or site geologist professional judgment may be used to adjust sampling points presented in Table 3-1, assist in determining sample shipping requirements, and support worker health and safety monitoring. Section 3.6.3 describes radiological field screening methods.

3.5.1.2 Geophysical Logging

The planned boreholes and groundwater monitoring wells will be geophysically logged with the high-resolution, spectral gamma-ray logging system to determine the vertical distribution and concentration of gamma-emitting radionuclides. Soil moisture will be determined using a neutron logging tool. The groundwater monitoring wells and boreholes will be logged before the casing is telescoped and

before the borehole is decommissioned. The starting point for logging will be recorded; this is usually at the ground surface or the top of the casing. Boreholes will be decommissioned with RL, Ecology, and EPA approval, in accordance with WAC 173-160, after geophysical logging and sampling is completed.

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
<p>100-D-4</p> <p>One test pit will be excavated to a depth of the capabilities of the excavator or 20 ft bgs, whichever comes first.</p> <p>Justification: This waste site is being characterized because the depth of remedial action at this site is approximate to or less than the depth of the engineered structure, concentrations of some contaminants in soil exceeded MTCA 2007 (WAC 173-340) values, and the sludge received at this site represents the highest radioactive inventory for retention basins.</p>	9-11, 11-13, 13-15, 15-17, 17-19 by backhoe (5 samples).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-4.	None	None
<p>116-D-4</p> <p>One test pit will be excavated to a depth of the capabilities of the excavator or 20 ft bgs, whichever comes first.</p> <p>Justification: This waste site is being characterized because the depth of remedial action at this site is approximate to or less than the depth of the engineered structure, cleanup verification sample analysis did not include all inventoried contaminants for this site, and it is associated with effluent from a high priority Cr(VI) site (108-D Building).</p>	9-11, 11-13, 13-15, 15-17, 17-19 by backhoe (5 samples).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-6.	None	None
<p>100-D-12 Pump Station/French Drain</p> <p>One test pit will be excavated to a depth of the capabilities of the excavator or 25 ft bgs, whichever comes first.</p> <p>Justification: This waste site is being characterized because it is suspected of being the source of the Cr(VI) groundwater plumes and the depth of remedial action at this site is approximate to or less than the depth of the engineered structure. The site was remediated to a depth of 8 ft; however, the bottom of the engineered structure is reported as 6 ft and 20 ft.</p>	8-10, 10-12, 13-15, 15-17, 17-19, 19-21, 21-23, 23-25 by backhoe (8 samples).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-3.	None	None

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
<p>116-H-2</p> <p>One test pit will be excavated to a depth of the capabilities of the excavator or 20 ft bgs, whichever comes first.</p> <p>Justification: This waste site is being characterized because it is suspected that contamination extends beyond the depth of removal, treatment, and disposal; cleanup verification sample analysis did not include all inventoried contaminants for this site; and it is a high volume liquid waste site.</p>	9-11, 11-13, 13-15, 15-17, 17-19 by backhoe (5 samples).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-12.	None	None
<p>1607-H4</p> <p>One test pit will be excavated to a depth of the capabilities of the excavator or 20 ft bgs, whichever comes first.</p> <p>Justification: This waste site is being characterized because elevated metals and PAH concentrations were found in tank sludge; cleanup verification samples had elevated PAH concentrations; and depth to groundwater in the area is shallow (approximately 28.9 ft).</p>	11-13, 13-15, 15-17, 17-19 by backhoe (4 samples).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-17.	None	None

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
116-D-1B Trench One borehole to groundwater. Justification: This site received 1,100 kg of sodium dichromate. Comparison of soil column pore volume (932 m ³) and the effluent discharge volume (200 m ³) suggests groundwater has not been impacted at this site (WHC-EN-TI-181. Therefore, residual Cr(VI) contamination may exist in the vadose zone beneath this site. Residual contamination in the soil column also is above screening levels for groundwater protection, and the site is located upgradient from the Cr(VI) groundwater plume. In samples collected during the limited field investigation (DOE/RL-93-29), additional contaminants were detected below the depth of remediation in the borehole drilled into this waste site. The highest concentrations of heavy metals were found at depths of approximately 30 ft. Chromium, lead, and nickel exhibited this behavior with chromium and lead showing a smaller but distinct high at 15 ft. The highest concentration of Sr-90 was found in the upper 10 ft. Highest concentrations of radionuclides (Co-60, Eu-152, Eu-154, Pu-239, and Sr-90) are found above 30 ft, decreasing to near zero by 50 ft.	15-17.5, 20-22.5, 25-27.5, 30-32.5, 35-37.5, 40-42.5, 45-47.5, 50-52.5, 55-57.5, 60-62.5, 65-67.5, 70-72.5, 75-77.5, 77.5-80, 80-82.5, 82.5-85 (87.5-90 ^c aquifer sediment sample) by split spoon (<u>17 samples</u>).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-5. Aquifer sediment sample will be analyzed for metals, Cr(VI), and batch leach test in accordance with Table 2-5. Aquifer sediment sample analyses will include K _d determinations for metals and Cr(VI).	During drilling 87.5-90 ^c aquifer water sample (<u>1 filtered groundwater sample</u>).	Filtered groundwater samples will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K _d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.
	Major formation and lithology changes by split spoon (<u>2 samples</u>).	Physical properties in accordance with Table 2-5.		

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
116-DR-1&2 Trench One borehole to groundwater. Justification: This site is being characterized because the depth of removal, treatment, and disposal was less than the reported site design depth. It is suspected that contamination extends beyond the remediated depth of 5 m (16.4 ft) (CVP-2000-00002, 2002). The reported soil concentrations for contaminants exceed MTCA 2007 (WAC 173-340). The cleanup verification sample analysis did not include all inventoried contaminants for the site. In addition, it is believed effluent reached groundwater during operations.	15-17.5, 20-22.5, 25-27.5, 30-32.5, 35-37.5, 40-42.5, 45-47.5, 50-52.5, 55-57.5, 57.5-60, 60-62.5, 62.5-64 (64-66.5° aquifer sediment sample) by split spoon (<u>13 samples</u>).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-8. Aquifer sediment sample will be analyzed for metals, Cr(VI), and batch leach test in accordance with Table 2-8. Aquifer sediment sample analyses will include K _d determinations for metals and Cr(VI).	During drilling 64-66.5° aquifer water sample (<u>1 filtered groundwater sample</u>).	Filtered groundwater samples will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K _d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.
	Major formation and lithology changes by split spoon (<u>2 samples</u>).	Physical properties in accordance with Table 2-8.		
116-D-7 Retention Basin One borehole to groundwater. Justification: Residual contamination extends beyond the depth of remedial action at 24.3 ft. Contaminants present include Cs-137, Eu-152, Eu-154, Ni-63, and Cr(VI). Groundwater was impacted by the operation of this site.	15-17.5, 20-22.5, 25-27.5, 30-32.5, 35-37.5, 40-42.5, 45-47.5, 50-52.5, 52.5-55, 55-57.5, 57.5-60 (62.5-65.0° aquifer sediment sample) by split spoon (<u>12 samples</u>).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-7. Aquifer sediment sample will be analyzed for metals, Cr(VI), and batch leach test in accordance with Table 2-7. Aquifer sediment sample analyses will include K _d determinations for metals and Cr(VI).	During drilling 62.5-65° aquifer water sample (<u>1 filtered groundwater sample</u>).	Filtered groundwater samples will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K _d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.
	Major formation and lithology changes by split spoon (<u>2 samples</u>).	Physical properties in accordance with Table 2-7.		

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
116-DR-9 Retention Basin One borehole to groundwater. Justification: Residual contamination extends beyond the depth of remedial action at 15.6 ft. Contaminants present include Cs-137, Eu-152, Eu-154, Ni-63, and Cr(VI). Groundwater was impacted by the operation of this site.	15-17.5, 20-22.5, 25-27.5, 30-32.5, 35-37.5, 40-42.5, 45-47.5, 50-52.5, 52.5-55, 55-57.5, 57.5-60, 60-62.5, 62.5-65 (65-68 ^c aquifer sediment sample) by split spoon (<u>14 samples</u>).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-9. Aquifer sediment sample will be analyzed for metals, Cr(VI), and batch leach test in accordance with Table 2-9. Aquifer sediment sample analyses will include K _d determinations for metals and Cr(VI).	During drilling 65.5-68 ^c aquifer water sample (<u>1 filtered groundwater sample</u>).	Filtered groundwater samples will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K _d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.
	Major formation and lithology changes by split spoon (<u>2 samples</u>).	Physical properties in accordance with Table 2-9.		
116-H-1 Trench One borehole to groundwater. Justification: Contamination extends beyond the depth of remedial action at 15 ft. Contaminants present include Cs-137, Co-6, Eu-152, Eu-154, Sr-90, and Cr(VI). Groundwater has been impacted beneath this site. In addition, Sr-90 is detected in downgradient groundwater-monitoring wells.	15-17.5, 20-22.5, 25-27.5, 30-32.5, 32.5-35, 35-37.5, 37.5-40 (43.5-45 ^c aquifer sediment sample) by split spoon (<u>8 samples</u>).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-11. Aquifer sediment sample will be analyzed for metals, Cr(VI), and batch leach test in accordance with Table 2-11. Aquifer sediment sample analyses will include K _d determinations for metals and Cr(VI).	During drilling 43.5-45 ^c aquifer water sample (<u>1 filtered groundwater sample</u>).	Filtered groundwater samples will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K _d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.
	Major formation and lithology changes by split spoon (<u>2 samples</u>).	Physical properties in accordance with Table 2-11.		

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
<p>116-H-4 Pluto Crib</p> <p>One borehole to groundwater.</p> <p>Justification: This site was exhumed during the construction of the 117-H building in 1960. The depth of soil removal is not well documented. It is unknown whether the contamination in the soil column beneath this site was removed. Data does not exist to determine the nature and extent of contamination. This site was a significant source of coolant waste containing concentrated chromium and sodium dichromate.</p>	<p>5-7.5, 10-12.5 12.5-15, 15-17.5, 20-22.5, 25-27.5, 30-32.5, 35-37.5, 37.5-40, 40-42.5, 42.5-45 (47.5-50^c aquifer sediment sample) by split spoon (<u>12 samples</u>).</p>	<p>Target analytes, field screening parameters, and batch leach test in accordance with Table 2-13. Aquifer sediment sample will be analyzed for metals Cr(VI), and batch leach test in accordance with Table 2-13. Aquifer sediment sample analyses will include K_d determinations for metals and Cr(VI).</p>	<p>During drilling 47.5-50^c aquifer water sample (<u>1 filtered groundwater sample</u>).</p>	<p>Filtered groundwater samples will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K_d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.</p>
	<p>Major formation and lithology changes by split spoon (<u>2 samples</u>).</p>	<p>Physical properties in accordance with Table 2-13.</p>		
<p>116-H-7 Retention Basin</p> <p>One borehole to groundwater.</p> <p>Justification: Residual contamination extends beyond the depth of remedial action at 15.7 ft. Contaminants present include Cs-137, Eu-152, Eu-154, Sr-90, Ni-63, Pu-239/240, lead, and Cr(VI). In addition, Sr-90 has been detected downgradient groundwater-monitoring wells. The depth of remedial action (15.7 ft) relative to the bottom of the engineered structure (14.2 ft) suggests additional characterization is needed. In addition, lateral contamination was reported during other investigations (e.g. UNI-946); therefore, this borehole will be placed to also address uncertainty regarding the lateral extent of remediation.</p>	<p>15.5-18, 20-22.5, 25-27.5, 27.5-30, 30-32.5, 32.5-35, 35-37.5 (39.5-42^c aquifer sediment sample) by split spoon (<u>8 samples</u>).</p>	<p>Target analytes, field screening parameters, and batch leach test in accordance with Table 2-15. Aquifer sediment sample will be analyzed for metals, Cr(VI), and batch leach test in accordance with Table 2-15. Aquifer sediment sample analyses will include K_d determinations for metals and Cr(VI).</p>	<p>During drilling 39.5-42^c aquifer water sample (<u>1 filtered groundwater sample</u>).</p>	<p>Filtered groundwater samples will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K_d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.</p>
	<p>Major formation and lithology changes by split spoon (<u>2 samples</u>).</p>	<p>Physical properties in accordance with Table 2-15.</p>		

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
<p>118-H-6 Reactor Fuel Storage Basin</p> <p>One borehole to groundwater.</p> <p>Justification: This borehole will be located at the site of a possible fuel storage basin leak at the 118-H-6 Reactor (BHI-00127). Residual contamination extends beyond the remedial action depth. The borehole is located within the area of the leak and based on contamination detected 0 to 1 ft below the depth of remedial action. The data in this shallower zone indicated that some residual contamination is present. Additionally, this borehole will be drilled to satisfy external requirements to evaluate the nature and extent of contamination beneath reactor structures.</p>	<p>20-22.5, 25-27.5, 30-32.5, 35-37.5, 37.5-40, 40-42.5, 42.5-45, 45-47.5 (49.5-52° aquifer sediment sample) by split spoon (9 samples).</p>	<p>Target analytes, field screening parameters, and batch leach test in accordance with Table 2-16. Aquifer sediment sample will be analyzed for metals, Cr(VI), and batch leach test in accordance with Table 2-16. Aquifer sediment sample analyses will include K_d determinations for metals and Cr(VI).</p>	<p>During drilling 49.5-52° aquifer water sample (1 filtered groundwater sample).</p>	<p>Filtered groundwater samples will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K_d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.</p>
	<p>Major formation and lithology changes by split spoon (2 samples).</p>	<p>Physical properties in accordance with Table 2-16.</p>		
<p>116-H-6 Solar Evaporation Basin</p> <p>One borehole to groundwater.</p> <p>Justification: This site is being characterized because it is not "clean closed" due to nitrate and fluoride remaining in soil column; the site is a suspected Cr(VI) source to groundwater; and radiological contamination is believed to be present below the depth of removal, treatment, and disposal at the site. Eight boreholes have been drilled in and adjacent to the 116-H-6 Solar Evaporation basin, four inside and four outside the waste site boundary. Most of the contamination detected was near BH-1 199-H4-50; therefore, the borehole will be placed near 199-H4-50. Additional removal, treatment, and disposal is planned at this site.</p>	<p>10-12.5, 12.5-15, 20-22.5, 25-27.5, 30-32.5, 32.5-35, 35-37.5, 37.5-40, 40-42.5, 42.5-45 (45.5-48° aquifer sediment sample) by split spoon (11 samples).</p>	<p>Target analytes, field screening parameters, and batch leach test in accordance with Table 2-14. Aquifer sediment sample will be analyzed for metals, Cr(VI), and batch leach test in accordance with Table 2-14. Aquifer sediment sample analyses will include K_d determinations for metals and Cr(VI).</p>	<p>During drilling 45.5-48° aquifer water sample (1 filtered groundwater sample).</p>	<p>Filtered groundwater samples will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K_d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.</p>
	<p>Major formation and lithology changes by split spoon (2 samples).</p>	<p>Physical properties in accordance with Table 2-14.</p>		

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
118-D-6 Reactor Fuel Storage Basin One borehole to groundwater. Justification: This site is being characterized because the fuel storage basin walls and floor were left in place. High concentrations of radionuclides and other contaminants were found on concrete samples. Concentrations of some contaminants in samples collected exceeded MTCA 2007 (WAC 173-340) values. The depth of remedial action is approximate to or less than the depth of the engineered structure and concentrations. The basin was reported to have leaked during operations. In addition, soil samples were not collected from beneath the basin floor.	15-17.5, 20-22.5, 25-27.5, 30-32.5, 35-37.5, 40-42.5, 45-47.5, 50-52.5, 55-57.5, 60-62.5, 65-67.5, 70-72.5, 75-77.5, 77.5-80, 80-82.5, 82.5-85 (87.5-90 ^c aquifer sediment sample) by split spoon (<u>17 samples</u>).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-10. Aquifer sediment sample will be analyzed for metals, Cr(VI), and batch leach test in accordance with Table 2-10. Aquifer sediment sample analyses will include K _d determinations for metals and Cr(VI).	During drilling 87.5-90 ^c aquifer water sample (<u>1 filtered groundwater sample</u>).	Filtered groundwater samples will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K _d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.
	Major formation and lithology changes by split spoon (<u>2 samples</u>).	Physical properties in accordance with Table 2-10.		

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
Well No. 2 to be drilled and installed in the unconfined aquifer in 100-D. Justification: Proposed to define the extent of Cr(VI) in groundwater.	During drilling, grab samples will be collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings. ^d	Geologic archive samples and field screening parameters in accordance with Table 2-18.	During drilling, samples to be collected at approximately 84, 89, 94, 99, and 104 ^f (<u>5 samples</u>).	Unfiltered groundwater samples will be analyzed for constituents and field screening parameters in accordance with Table 2-19.
	During drilling, samples to be collected at approximate depths of 69, 74, 79, 82, and 84 (89 and 94 to 100 aquifer sediment samples) ^e by split spoon (<u>7 samples</u>).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-18. Aquifer sediment samples will be analyzed for metals, Cr(VI), and batch leach test in accordance with Table 2-18. Aquifer sediment sample analyses will include K _d determinations for metals and Cr(VI).	During drilling, samples to be collected at approximately 89 and 94 to 100 ft bgs ^f (<u>2 filtered groundwater samples</u>).	Filtered groundwater sample will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K _d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.
	Major formation and lithology changes, and at approximately 54, 59, 64, and 69 ^g by split spoon. Samples for grain size analysis can be collected by drive barrel (<u>4 samples</u>).	Physical properties in accordance with Table 2-18.		

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
<p>Well No. 3 to be drilled and installed in the unconfined aquifer in 100-D.</p> <p>Justification: Proposed to define the extent of Cr(VI) and Sr-90 in groundwater.</p>	During drilling grab samples will be collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings. ^d	Geologic archive samples and field screening parameters in accordance with Table 2-18.	During drilling, samples to be collected at approximately 82.5, 97.5, 92.5, 97.5, and 102.5 ^f (5 samples).	Unfiltered groundwater samples will be analyzed for constituents and field screening parameters in accordance with Table 2-19.
	During drilling, samples to be collected at approximate depths of 67.5, 72.5, 77.5, 80.5, (82.5, 87.5, and 92.5 to 98.5 aquifer sediment samples) ^e by split spoon (7 samples).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-18. Aquifer sediment samples will be analyzed for metals, Cr(VI), and batch leach test in accordance with Table 2-18. Aquifer sediment sample analyses will include K _d determinations for metals and Cr(VI).	During drilling, collect sample at approximately 87.5 ^f (1 filtered groundwater sample).	Filtered groundwater sample will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K _d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.
	Major formation and lithology changes, and at approximately 46, 51, 56, and 61 ^g by split spoon. Samples for grain size analysis can be collected by drive barrel (4 samples).	Physical properties in accordance with Table 2-18.		

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
<p>Well No. 4 to be drilled and installed in the unconfined aquifer in 100-D.</p> <p>Justification: Proposed to assess vadose zone contamination beneath the remediated waste site (116-D-1A) and define the extent of Cr(VI) and Sr-90 in groundwater.</p>	During drilling, grab samples will be collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings. ^d	Geologic archive samples and field screening parameters in accordance with Table 2-5.	During drilling, samples to be collected at approximately 86, 91, 96, 101, and 106 ^f (<u>5 samples</u>).	Unfiltered groundwater samples will be analyzed for constituents and field screening parameters in accordance with Table 2-19.
	15-17.5, 20-22.5, 25-27.5, 30-32.5, 35-37.5, 40-42.5, 45-47.5, 50-52.5, 55-57.5, 60-62.5, 65-67.5, 70-72.5, 75-77.5, 77.5-80, 80-82.5, 82.5-85 (86 ^c , 91, and 96 to 102 aquifer sediment samples) ^f by split spoon (<u>20 samples</u>).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-5. Aquifer sediment samples will be analyzed for metals, Cr(VI), and batch leach test in accordance with Table 2-5. Aquifer sediment sample analyses will include K _d determinations for metals and Cr(VI).	During drilling, at approximately 91 ^f (<u>1 filtered groundwater sample</u>).	Filtered groundwater sample will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K _d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.
	Major formation and lithology changes, and at approximately 50, 55, 60, and 65 ^g by split spoon. Samples for grain size analysis can be collected by drive barrel (<u>4 samples</u>).	Physical properties in accordance with Table 2-5.		

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
Well No. 5 to be drilled and installed in the unconfined aquifer in 100-D. Justification: Proposed to define the extent of Cr(VI) and Sr-90 in groundwater.	During drilling grab samples will be collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings. ^d	Geologic archive samples and field screening parameters in accordance with Table 2-18.	During drilling, samples to be collected at approximately 83.5, 88.5, 93.5, 98.5, and 103.5 ^f (<u>5 samples</u>).	Unfiltered groundwater samples will be analyzed for constituents and field screening parameters in accordance with Table 2-19.
	During drilling, samples to be collected at approximate depths of 68.5, 73.5, 78.5, 81.5 (83.5, 88.5, and 93.5 to 99.5 aquifer sediment samples) ^e by split spoon (<u>7 samples</u>).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-18. Aquifer sediment samples will be analyzed for metals, Cr(VI), and batch leach test in accordance with Table 2-18. Aquifer sediment sample analyses will include K _d determinations for metals and Cr(VI).	During drilling, collect sample at approximately 88.5 ^f (<u>1 filtered groundwater sample</u>).	Filtered groundwater sample will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K _d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.
	Major formation and lithology changes, and at approximately 57, 62, 67, and 72 ^g by split spoon. Samples for grain size analysis can be collected by drive barrel (<u>4 samples</u>).	Physical properties in accordance with Table 2-18.		

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
<p>Well No. 9 to be drilled and installed in the unconfined aquifer in 100-D.</p> <p>Justification: Proposed to define the extent of Cr(VI) in soil and groundwater. This well will be installed at the location of a hole in the 100-D-56 Sodium Dichromate Pipelines. Samples will be collected through the vadose zone to assess a potential vadose source of Cr(VI) related to leaks from the dichromate pipeline.</p>	During drilling grab samples will be collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings. ^d	Geologic archive samples and field screening parameters in accordance with Table 2-18.	During drilling, samples to be collected at approximately 84.5, 89.5, 94.5, 99.5, and 104.5 ^f (5 samples).	Unfiltered groundwater samples will be analyzed for constituents and field screening parameters in accordance with Table 2-19.
	15-17.5, 20-22.5, 25-27.5, 30-32.5, 35-37.5, 40-42.5, 45-47.5, 50-52.5, 52.5-55, 55-57.5, 60-62.5, 65-67.5, 70-72.5, 75-77.5, 80-82.5, 82.5-85 (85, 90, and 95 to 101 ^c aquifer sediment sample) by split spoon (19 samples).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-18. Aquifer sediment sample will be analyzed for metals, Cr(VI), and batch leach test in accordance with Table 2-18. Aquifer sediment sample analyses will include K _d determinations for metals and Cr(VI).	During drilling, collect sample at approximately 89.5 ^f (1 filtered groundwater sample).	Filtered groundwater sample will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K _d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.
	Major formation and lithology changes, and 10 ft, and 5 ft above the Hanford Ringold contact, at the Hanford Ringold contact, and 5 ft below the Hanford Ringold contact by split spoon. Samples for grain size analysis can be collected by drive barrel (4 samples).	Physical properties in accordance with Table 2-18.		

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
Well No. 6 to be drilled and installed in the unconfined aquifer in 100-H. Justification: Proposed to define the extent of Sr-90 in groundwater.	During drilling grab samples will be collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings. ^d	Geologic archive samples and field screening parameters in accordance with Table 2-18.	During drilling, samples to be collected at approximately 39.5, 44.5, 49.5, 54.5, and 59.5 ft bgs ^f (5 samples).	Constituents and field screening parameters in accordance with Table 2-19. Filtered groundwater sample for metals and Cr(VI) in accordance with Table 2-19 to support K _d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.
	During drilling, samples to be collected at approximate depths of 24.5, 29.5, 34.5, 37.5, (39.5, 44.5, and 49.5 aquifer sediment samples) ^e by split spoon (7 samples).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-18. Aquifer sediment samples will be analyzed for metals, Cr(VI), and batch leach test in accordance with Table 2-18. Aquifer sediment sample analyses will include K _d determinations for metals and Cr(VI).	During drilling, collect sample at approximately 44.5 ^f (1 filtered groundwater sample).	
	Major formation and lithology changes; samples for grain size analysis can be collected by drive barrel (2 samples).	Physical properties in accordance with Table 2-18.		

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
<p>Well No. 7 to be drilled and installed in the unconfined aquifer in 100-H.</p> <p>Justification: Proposed to define the extent of Sr-90 in groundwater.</p>	During drilling grab samples will be collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings. ^d	Geologic archive samples and field screening parameters in accordance with Table 2-18.	During drilling, samples to be collected at approximately 47, 52, 57, 62, and 67 ^f (<u>5 samples</u>).	Unfiltered groundwater samples will be analyzed for constituents and field screening parameters in accordance with Table 2-19.
	During drilling, samples to be collected at approximate depths of 27, 32, 37, 40 (42, 47, and 52 aquifer sediment samples) ^e by split spoon (<u>7 samples</u>).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-18. Aquifer sediment samples will be analyzed for metals, Cr(VI), and batch leach test in accordance with Table 2-18. Aquifer sediment sample analyses will include K _d determinations for metals and Cr(VI).	During drilling, collect sample at approximately 52 ft bgs ^f (<u>1 filtered groundwater sample</u>).	Filtered groundwater sample will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K _d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.
	Major formation and lithology changes by split spoon. Samples for grain size analysis can be collected by drive barrel (<u>2 samples</u>).	Physical properties in accordance with Table 2-18.		

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
<p>Well No. 10 to be drilled and installed in the unconfined aquifer in 100-H.</p> <p>Justification: Proposed to define the extent of Sr-90 and monitor nitrate in groundwater.</p>	During drilling grab samples will be collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings. ^d	Geologic archive samples and field screening parameters in accordance with Table 2-18.	During drilling, samples to be collected at approximately 39, 44, 49, 54, and 59 ^f (<u>5 samples</u>).	Unfiltered groundwater samples will be analyzed for constituents and field screening parameters in accordance with Table 2-19.
	During drilling, samples to be collected at approximate depths of 24, 29, 34, 37 (39, 44, and 49) ^e by split spoon (<u>7 samples</u>).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-18. Aquifer sediment samples will be analyzed for metals, Cr(VI), and batch leach test in accordance with Table 2-18. Aquifer sediment sample analyses will include K _d determinations for metals and Cr(VI).	During drilling, collect sample at approximately 44 ^f (<u>1 filtered groundwater sample</u>).	Filtered groundwater sample will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K _d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.
	Major formation and lithology changes by split spoon. Samples for grain size analysis can be collected by drive barrel (<u>2 samples</u>).	Physical properties in accordance with Table 2-18.		

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
Well No. 11 to be drilled and installed in the unconfined aquifer in 100-H. Justification: Proposed to monitor nitrate in groundwater.	During drilling grab samples will be collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings. ^d	Geologic archive samples and field screening parameters in accordance with Table 2-18.	During drilling, samples to be collected at approximately 36.5, 41.5, 46.5, 51.5, and 56.5 ⁱ (<u>5 samples</u>).	Unfiltered groundwater samples will be analyzed for constituents and field screening parameters in accordance with Table 2-19.
	During drilling, samples to be collected at approximate depths of 21.5, 26.5, 31.5, 34.5 (36.5, 41.5, and 46.5) ^e by split spoon (<u>7 samples</u>).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-18. Aquifer sediment samples will be analyzed for metals, Cr(VI), and batch leach test in accordance with Table 2-18. Aquifer sediment sample analyses will include K _d determinations for metals and Cr(VI).	During drilling, collect sample at approximately 41.5 ^f (<u>1 filtered groundwater sample</u>).	Filtered groundwater sample will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K _d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.
	Major formation and lithology changes by split spoon. Samples for grain size analysis can be collected by drive barrel (<u>2 samples</u>).	Physical properties in accordance with Table 2-18.		

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
<p>Well No. 12 to be drilled and installed in the unconfined aquifer in 100-H.</p> <p>Justification: Proposed to monitor contaminants in groundwater downgradient of the 1607-H3 Septic Tank and Field.</p>	During drilling grab samples will be collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings. ^d	Geologic archive samples and field screening parameters in accordance with Table 2-18.	During drilling, samples to be collected at approximately 23, 28, 33, 38, and 43 ^f (<u>5 samples</u>).	Unfiltered groundwater samples will be analyzed for constituents and field screening parameters in accordance with Table 2-19.
	During drilling, samples to be collected at approximate depths of 8, 13, 18, 21 (23, 28, and 33) ^e by split spoon (<u>7 samples</u>).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-18. Aquifer sediment sample will be analyzed for metals, Cr(VI), and batch leach test in accordance with Table 2-18. Aquifer sediment sample analyses will include K _d determinations for metals and Cr(VI).	During drilling, collect sample at approximately 28 ^f (<u>1 filtered groundwater sample</u>).	Filtered groundwater sample will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K _d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.
	Major formation and lithology changes by split spoon. Samples for grain size analysis can be collected by drive barrel (<u>2 samples</u>).	Physical properties in accordance with Table 2-18.		

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
<p>Well R1</p> <p>Drill and sample soil and groundwater through the Ringold Upper Mud Unit and into Ringold Formation Unit B and complete as well in the Ringold Upper Mud Unit in 100-H.</p> <p>Justification: This data is needed to evaluate alternative conceptual site model (CSM) components regarding whether groundwater contamination is from vadose zone sources (in the periodically wetted zone), within the unconfined aquifer, above the Ringold Upper Mud Unit, or within the Ringold Upper Mud Unit and diffusing to the unconfined aquifer.</p>	During drilling grab samples will be collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings. ^d	Geologic archive samples and field screening parameters in accordance with Table 2-18.	During drilling, samples to be collected at approximately 37, 42, 47, 52, and 57 ^f , and from water-bearing intervals of the Ringold Upper Mud Unit and one water sample from Ringold Formation Unit B if sufficient water is available (<u>8 samples</u>).	Unfiltered groundwater samples will be analyzed for constituents and field screening parameters in accordance with Table 2-19.
	During drilling, samples to be collected at approximate depths of 22, 27, 32, 35 (37, 42, and 47 aquifer sediment samples) ^e and at approximate depths of 55, 80, and 105 ^h by split spoon (<u>10 samples</u>).	Radiological methods, metals, Cr(VI), field screening parameters, and batch leach test in accordance with Table 2-18. Aquifer sediment sample will be analyzed for metals, Cr(VI), and batch leach test in accordance with Table 2-18. Aquifer sediment sample analyses will include K _d determinations for metals and Cr(VI).	During drilling, sample to be collected at approximately 42 ^f (<u>1 filtered groundwater sample</u>).	Filtered groundwater sample will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K _d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.
	Major formation and lithology changes (<u>2 samples</u>).	Physical properties in accordance with Table 2-18.		

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
<p>Well R2</p> <p>Drill and sample soil and groundwater through the Ringold Upper Mud Unit and into Ringold Formation Unit B and complete as well in the Ringold Upper Mud Unit in 100-H.</p> <p>Justification: This data is needed to evaluate alternative CSM components regarding whether groundwater contamination is from vadose zone sources (in the periodically wetted zone), within the unconfined aquifer, above the Ringold Upper Mud Unit, or within the Ringold Upper Mud Unit and diffusing to the unconfined aquifer.</p>	During drilling grab samples will be collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings. ^d	Geologic archive samples and field screening parameters in accordance with Table 2-18.	During drilling, samples to be collected at approximately 37.5, 42.5, 47.5, 47.5, and 52.5 ⁱ , and from water-bearing intervals of the Ringold Upper Mud Unit and one water sample from Ringold Formation Unit B if sufficient water is available (<u>8 samples</u>).	Unfiltered groundwater samples will be analyzed for constituents and field screening parameters in accordance with Table 2-19.
	During drilling, samples to be collected at approximate depths of 22.5, 27.5, 32.5, 35.5 (37.5, 42.5, and 47.5 aquifer sediment samples) ^e and at approximate depths of 55, 80, and 105 ^h by split spoon (<u>10 samples</u>).	Radiological methods, metals, Cr(VI), field screening parameters, and batch leach test in accordance with Table 2-18. Aquifer sediment samples will be analyzed for metals, Cr(VI), and batch leach test in accordance with Table 2-18. Aquifer sediment sample analyses will include K _d determinations for metals and Cr(VI).	During drilling, collect sample at approximately 42.5 ^f (<u>1 filtered groundwater sample</u>).	Filtered groundwater sample will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K _d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.
	Major formation and lithology changes (<u>2 samples</u>).	Physical properties in accordance with Table 2-18.		

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
<p>Well R3</p> <p>Drill and sample soil and groundwater from through the Ringold Upper Mud Unit and into Ringold Formation Unit B and complete as well in the Ringold Upper Mud Unit in 100-H.</p> <p>Justification: This data is needed to evaluate alternative CSM components regarding whether groundwater contamination is from vadose zone sources (in the periodically wetted zone), within the unconfined aquifer, above the Ringold Upper Mud Unit, or within the Ringold Upper Mud Unit and diffusing to the unconfined aquifer.</p>	During drilling grab samples will be collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings. ^d	Geologic archive samples and field screening parameters in accordance with Table 2-18.	During drilling, samples to be collected at approximately 31.5, 36.5, 41.5, 46.5, and 51.5 ^f and from water-bearing intervals of the Ringold Upper Mud Unit and one water sample from Ringold Formation Unit B if sufficient water is available (<u>8 samples</u>).	Unfiltered groundwater samples will be analyzed for constituents and field screening parameters in accordance with Table 2-19.
	During drilling, samples to be collected at approximate depths of 11.5, 16.5, 21.5, 24.5 (26.5, 31.5, and 36.5 aquifer sediment samples) ^e and at approximate depths of 40, 65, and 90 ^h by split spoon (<u>10 samples</u>).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-18. Aquifer sediment samples will be analyzed for metals, Cr(VI), and batch leach test in accordance with Table 2-18. Aquifer sediment sample analyses will include K _d determinations for metals and Cr(VI).	During drilling, collect sample at approximately 36.5 ^f (<u>1 filtered groundwater sample</u>).	Filtered groundwater sample will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K _d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.
	Major formation and lithology change by split spoon (<u>2 sample</u>).	Physical properties in accordance with Table 2-18.		

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
<p>Well R4</p> <p>Drill and sample soil and groundwater from through the Ringold Upper Mud Unit and into Ringold Formation Unit B and complete as well in the Ringold Upper Mud Unit in 100-D.</p> <p>Justification: This data is needed to evaluate alternative CSM components regarding whether groundwater contamination is from vadose zone sources (in the periodically wetted zone), within the unconfined aquifer, above the Ringold Upper Mud Unit, or within the Ringold Upper Mud Unit and diffusing to the unconfined aquifer.</p>	During drilling grab samples will be collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings. ^d	Geologic archive samples and field screening parameters in accordance with Table 2-18.	During drilling, samples to be collected at approximately 83, 88, 93, 98, and 103 ^f , and from water-bearing intervals of the Ringold Upper Mud Unit and one water sample from Ringold Formation Unit B if sufficient water is available (<u>8 samples</u>).	Unfiltered groundwater samples will be analyzed for constituents and field screening parameters in accordance with Table 2-19.
	During drilling, samples to be collected at approximate depths of 68, 73, 78, 81 (83, 88, and 93) ^e and at approximate depths of 99, 124, and 149 ^h by split spoon (<u>10 samples</u>).	Radiological methods, metals, Cr(VI), field screening parameters, and batch leach test in accordance with Table 2-18. Aquifer sediment samples will be analyzed for metals, Cr(VI), and batch leach test in accordance with Table 2-18. Aquifer sediment sample analyses will include K _d determinations for metals and Cr(VI).	During drilling, collect sample at approximately 88 ^f (<u>1 filtered groundwater sample</u>).	Filtered groundwater sample will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K _d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.
	Major formation and lithology changes, and approximately 89, 94, 99, and 104 ^g by split spoon (<u>4 samples</u>).	Physical properties in accordance with Table 2-18.		

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
<p>Well R5</p> <p>Drill and sample soil and groundwater from through the Ringold Upper Mud Unit and into Ringold Formation Unit B and completed in the Ringold Upper Mud Unit at 100-D-12 in the 100-D area. If well is at the same location as the test pit, the test it will be installed and backfilled before the well is installed.</p> <p>Justification: This data is needed to evaluate alternative CSM components regarding whether groundwater contamination is from vadose zone sources (in the periodically wetted zone), within the unconfined aquifer, above the Ringold Upper Mud Unit, or within the Ringold Upper Mud Unit and diffusing to the unconfined aquifer.</p>	During drilling grab samples will be collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings. ^d	Geologic archive samples and field screening parameters in accordance with Table 2-18.	During drilling, samples to be collected at approximately 82.5, 87.5, 92.5, 97.5, 102.5, 107.5, 112.5, and 117.5 ^f , and from water-bearing intervals of the Ringold Upper Mud Unit and one water sample from Ringold Formation Unit B if sufficient water is available (<u>11 samples</u>).	Unfiltered groundwater samples will be analyzed for constituents and field screening parameters in accordance with Table 2-19.
	25-27.5, 30-32.5, 35-37.5, 40-42.5, 45-47.5, 50-52.5, 55-57.5, 60-62.5, 65-67.5, 70-72.5, 72.5-75, 75-77.5, 77.5-80, 80-82.5, 82.5-85 (87.5-90 ^e and 120 aquifer sediment samples) by split spoon (<u>17 samples</u>).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-18. Aquifer sediment samples will be analyzed for metals, Cr(VI) and batch leach test in accordance with Table 18. Aquifer sediment sample analyses will include K _d determinations for metals and Cr(VI).	During drilling 87.5-90 and ~120.5 ^f (<u>2 filtered groundwater samples</u>).	Filtered groundwater sample will be analyzed for metals and Cr(VI) in accordance with Table 2-19 to support K _d determination. Cr(VI) data will be used, as possible, to refine the nature and extent of chromium contamination.
	During drilling, samples to be collected from the top, 25 and 50 into the Ringold Upper Mud Unit by split spoon (<u>3 samples</u>).	Target analytes, field screening parameters, and batch leach test in accordance with Table 2-18. Aquifer sediment sample analyses will include K _d determinations for metals and Cr(VI).		
	Major formation and lithology changes, and 10 and 5 ft above the Hanford Ringold contact, at the Hanford Ringold contact, and 5 ft below the Hanford Ringold contact by split spoon (<u>4 samples</u>).	Physical properties in accordance with Table 2-18.		

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
Sample 53 spatial and temporal uncertainty monitoring wells; three rounds.	None	None	Three rounds of sampling will be occur that will represent low (October 2009), high (May 2010), and transition (February 2010) river stages (53 wells x 3 rounds = 159 samples).	Constituents and field screening parameters in accordance with Table 2-19.
Sample 6 new aquifer tubes (Table 3-2); three rounds.	None	None	Three rounds of sampling will be occur that will represent low (October 2009), high (May 2010), and transition (February 2010) river stages (6 aquifer tubes x 3 rounds = 18 samples).	Constituents and field screening parameters in accordance with Table 2-19 (see Table 3-3 for additional information).
Estimated total number of samples. ⁱ	<u>Soil/Aquifer sediment chemical</u> : 302 <u>Physical property</u> : 64 <u>Geologic archive samples</u> : variable		<u>Water samples collected during drilling</u> : 110 <u>Spatial and temporal uncertainty samples</u> : 159 (3 rounds total) <u>Aquifer tube samples</u> : 18 samples (3 rounds total)	

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
Estimated minimum number of field quality control samples. ⁱ	<u>Soil/Aquifer sediment chemical:</u> 49 (16 equipment blank, 16 field blank, 16 duplicate, 1 split) <u>Physical property:</u> 0 <u>Geologic archive samples:</u> 0		<u>Water samples collected during drilling:</u> 19 (6 equipment blank, 6 field blank, 6 duplicate, 1 split) <u>Spatial and temporal uncertainty samples:</u> 30 (3 equipment blank, 3 field blank, 3 duplicate, 1 split each round, 3 total rounds) <u>Aquifer tube samples:</u> 9 (1 equipment blank, 1 field blank, 1 duplicate for each round, 3 total rounds)	
Estimated total number of samples. ⁱ	<u>Soil/aquifer sediment chemical:</u> 351 <u>Physical property:</u> 64 <u>Geologic archive samples:</u> variable		<u>Water samples collected during drilling:</u> 129 <u>Spatial and temporal uncertainty samples:</u> 189 <u>Aquifer tube samples:</u> 27	

Notes:

- Geologic samples will be logged. Boreholes and groundwater monitoring wells will be logged with a neutron moisture tool and the high-resolution, spectral gamma ray logging system. Information regarding the downhole geophysical logging analytical performance requirements is presented in Table 2-2.
- Upon visual observation of contamination, a depth discrete sample will be collected for applicable analysis. For example, if Cr(VI) contamination is observed at any interval other than those stated for sampling, a depth discrete sample would be collected for Cr(VI) analysis.
- This sample will be collected 5 ft into the water table.
- Archive samples may be omitted at the discretion of the field geologist due to radiological field data.
- Sample depths are approximate and based on historic information from the surrounding wells. Actual depths may vary from those listed. Samples are intended to be collected at 15, 10, 5, and 2 ft above water table, at the water table, 5 ft below the water table, and at the bottom of the unconfined aquifer.
- Depths are approximate and based on the average groundwater levels measured at wells in the area in 2008. Unfiltered groundwater samples are to be collected at 5-foot intervals through the unconfined aquifer. The filtered groundwater sample is to be collected at 5-feet into the water table. If a second filtered groundwater sample is to be collected, sample is to be collected at the bottom of the unconfined aquifer.
- Sample depths are approximate and based on historic information for surrounding wells and boreholes. Actual depths may vary by several meters from those listed. Samples are to be collected at 10 and 5 ft above Hanford-Ringold contact, at the Hanford-Ringold contact, and 5 ft below the Hanford-Ringold contact.

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth (ft bgs) ^b	Properties of Interest	Sample Interval Depth (ft bgs)	Analyte List
h. Sample depths are approximate and based on historic information for surrounding wells and boreholes. Actual depths may vary by several meters from those listed. Samples are to be collected at the top, 25 ft into, and 50 ft into the Ringold Upper Mud Unit.				
i. Number of samples is estimated. Actual number of samples collected may vary based on conditions encountered in the field (e.g., additional samples may be collected based on field observations).				
BHI-00127, 100-H Area Technical Baseline Report.				
DOE/RL-93-29, Limited Field Investigation Report for the 100-DR-1 Operable Unit.				
EPA/ROD/R10-95/126, Declaration of the Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units Hanford Site, Benton County, Washington.				
UNI-946, UNI-946, Radiological Characterization of the Retired 100 Areas.				
WAC 173-340, “Model Toxics Control Act—Cleanup,” 2007				
WHC-EN-TI-181, 1983, 100-D Area Technical Baseline Report.				
CSM = conceptual site model		MTCA = model toxics control act		
Cr(VI) = hexavalent chromium		PAH = polynuclear aromatic hydrocarbon		
K _d = distribution coefficient				

3.5.2 Groundwater Characterization

Groundwater characterization, including well activities, identification of wells to be sampled, well depth and screen placement, and well drilling and completion procedures, is discussed in this section. Figure 3-1 depicts the general well schematic.

3.5.2.1 New Groundwater Wells

Table 3-1 summarizes groundwater well activities. For each new well installed, slug tests will be performed after development. Larger scale pumping tests will be planned for groups of wells based on the results of the slug tests and proximity to key waste sites.

Well Depth and Screen Placement

For the five new groundwater wells in the unconfined aquifer in 100-D and five new groundwater wells in the unconfined aquifer in 100-H, a 6.1-m (20-ft) screen will be installed and centered so the middle of the screen is at the water table. For the two new groundwater wells in 100-D and the three new groundwater wells in 100-H to be drilled to Ringold Formation Unit B, up to a 6.1-m (20-ft) screen will be installed based on ability to produce water in the water-bearing Ringold Upper Mud Unit.

Well Drilling and Completion Procedures

Well drilling will be performed in accordance with WAC 173-160. The wells will be drilled using 25.4-cm (10-in.) diameter (or larger) casing to total depth. The drilling method will be determined based on discussions between the drilling lead and drilling contractor. Well decommissioning, when performed, will be in accordance with WAC 173-160.

The wells will be constructed as 15-cm (6-in.) wells with Schedule 10, Type 304 or 316 stainless steel, V-slot continuous wire wrap screen, atop a 1.5-m (5-ft)-long stainless steel sump with end cap.

A Schedule 10 stainless steel riser will be used to extend the permanent well into the vadose zone, with Schedule 10 carbon steel casing through the vadose zone to ground surface. Colorado silica sand will be used for the sand pack; sodium bentonite pellets and/or natural sodium bentonite chunks, crumbles, or powdered bentonite will be used for bentonite sealing material; and Type I/II Portland cement will be used for cement grout.

Surface construction consisting of protective casing, protective guard posts, and cement pad must be in place before job completion. The protective casing will be a minimum of 5 cm (2 in.) larger in diameter than the permanent casing. Protective casing will rise approximately 0.9 m (3 ft) above the ground surface. Permanent casing will rise to approximately 0.3 m (1 ft) below the top of the protective casing. Protective casing will have a lockable well cap extending approximately 38 cm (15 in.) above the top of the protective casing.

Final well design, including screen placement and length, will be determined by concurrence of the field geologist, drilling lead, and operable unit lead based upon field conditions. If the completion is different from WAC 173-160 requirements, then variances will be obtained from Ecology.

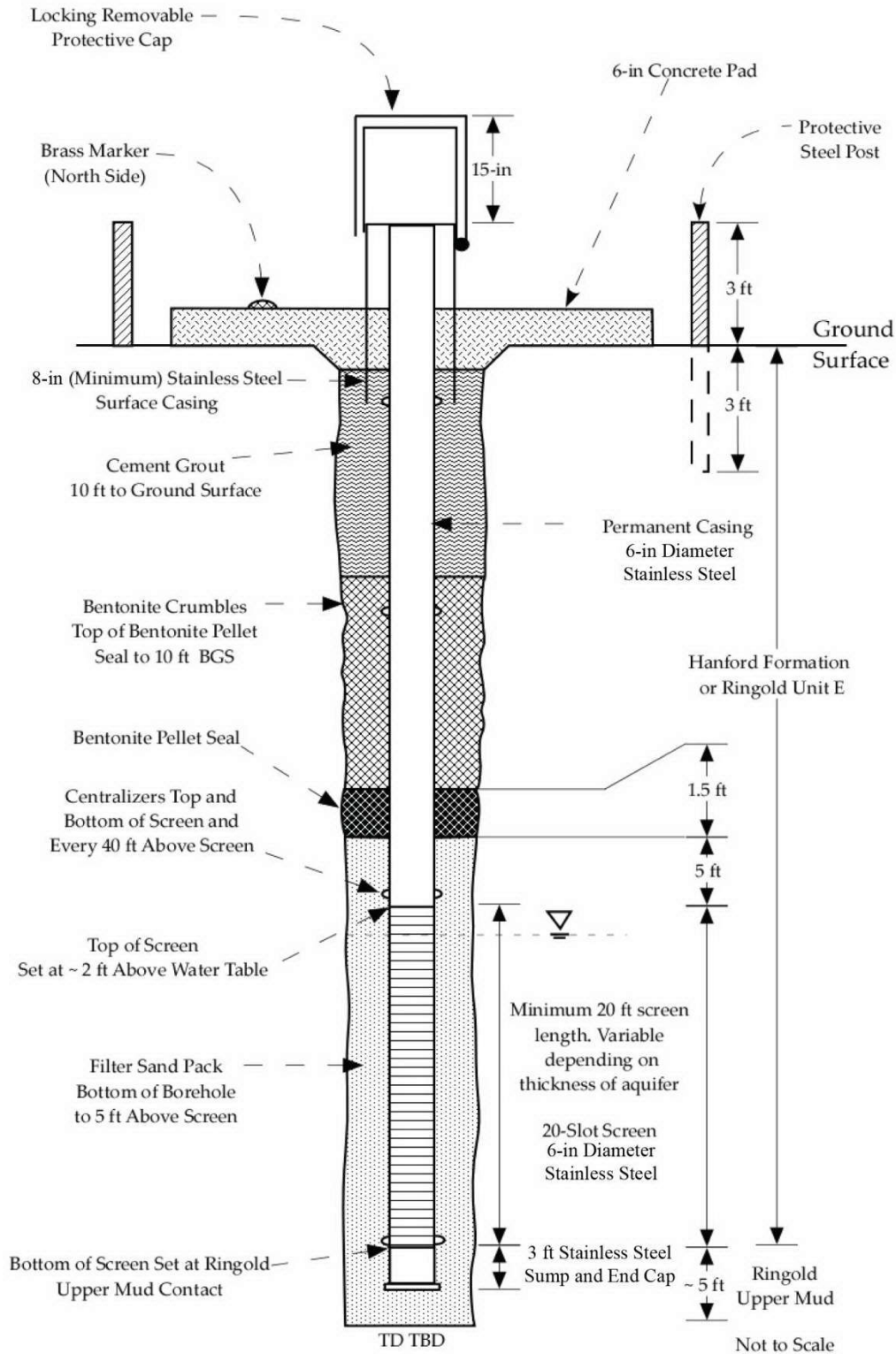


Figure 3-1. General Well Schematic

Slug Test and Pumping Test Procedures

During the slug test, the water level in a well is quickly changed by inserting, removing, or displacing a known volume of water. The subsequent water level response is then monitored and hydraulic parameters calculated using these data.

Slug testing equipment includes pressure transducer, data logger, slugging rod, and electric tape. The slug testing procedure generally includes the following steps:

- Measure and record the depth to water in the well.
- Measure and record the depth of the bottom of the well.
- Measure and record the radial distance from the pumping well to observation well(s).
- Install the pressure transducer at a depth below the water level that will not interfere with the lowering or withdrawal of the slugging rod. Record the transducer head reading as reference depth below water level.
- Displace water using the slugging rod.
- Monitor the water level until the pressure difference imposed by the slug has decayed, approximately equal to the duration of the test.

In single-well drawdown and recovery tests (pumping tests), the hydraulic response to pumping is monitored in the pumped well. The discharge rate during the test is maintained as close as possible to a constant flow. Multiple-well drawdown and recovery tests are aquifer tests in which the hydraulic response to pumping is monitored in at least one observation well located some distance from the pumping well.

Pump test equipment includes pump, flow meter, pressure transducer, data logger, reservoir, and measuring tape. The pumping test procedure generally includes the following steps:

- Measure and record the well dimensions, pumping and downhole equipment configuration.
- Measure and record the depth to water in the well and any observations wells.
- Measure and record the depth of the bottom of the well.
- Install the pump in the well at a depth to maximize the amount of available drawdown, or as specified in the supporting documentation, and record the pump intake depth.
- Install the pressure transducers in the pumping well and any observation wells and record the transducer(s) depth below water.
- Collect baseline data for a time period two to three times the expected test length, or longer.
- Set the data logger sample rate to the log-cycle. Begin recording while simultaneously starting the constant discharge test. Record the flow rate about every 10 minutes for the first hour after startup, then decrease the frequency to one reading every one-half hour.
- To conclude the pumping test, reset the data loggers to log-cycle recording rate. Begin recording while simultaneously shutting down the pump. Continue monitoring the recovery until the water level returns to pre-test levels.

3.5.2.2 Spatial and Temporal Uncertainty Groundwater Network Development

Table 3-1 summarizes spatial and temporal uncertainty groundwater well activities. Table 3-2 presents spatial and temporal uncertainty monitoring wells to be sampled. Three spatial and temporal uncertainty groundwater sample rounds, or events, will be performed to support the temporal uncertainty evaluation at 100-D/H for the RI.

Table 3-2. Spatial and Temporal Uncertainty Monitoring Well Network for 100-D/H

Well Numbers				
199-D2-6	199-D5-37	199-H3-4	199-H4-46	699-95-51
199-D2-11	199-D5-38	199-H3-5	199-H4-48	699-96-52B
199-D4-23	199-D5-41	199-H4-3	199-H5-1A	699-97-41
199-D4-84	199-D5-43	199-H4-5	199-H6-1	699-97-45
199-D5-13	199-D5-99	199-H4-6	699-87-55	699-97-48B
199-D5-14	199-D8-5	199-H4-9	699-90-45	699-98-43
199-D5-15	199-D8-55	199-H4-10	699-93-48A	699-98-49A
199-D5-16	199-D8-70	199-H4-11	699-94-41	699-98-51
199-D5-17	199-D8-71	199-H4-13	699-94-43	699-101-45
119-D5-18	199-D8-88	199-H4-16	699-95-45	
119-D5-19	199-H3-2A	199-H4-45	699-95-48	

To capture baseline aquifer conditions fully, it is required that samples represent spatial variations and changes occurring over time. Near the river, these varying conditions are observed as changes in groundwater flow, both direction and rate, causing temporary movement of contaminants through different portions of the unconfined aquifer. For areas bordering on the Columbia River, the changing aquifer conditions are caused by fluctuating river elevations associated with flood control and hydroelectric production. For representing baseline groundwater conditions, samples are required and will be collected to represent the varying aquifer conditions associated with the “low,” “transition,” and “high” river stages (October 2009, February 2010, and May 2010, respectively). The dates and frequency of sample collection are based on measurements of the river elevation to optimize collection of samples representing these temporal changes in groundwater conditions. This groundwater sampling schedule captures the maximum effects of changing river elevations on aquifer conditions as well as the transitional time between the maximum and minimum conditions.

The samples collected during all three events will be analyzed for the COPCs listed in Table 1-2 in accordance with performance requirements in Table 2-19. For the “low” river stage event, samples will also be analyzed for cyanide, pesticides, PCBs, polynuclear aromatic hydrocarbons (PAHs), and SVOCs in accordance with Table 2-19. If a validated detection is obtained, sample collection and analysis for the method at the well will be performed for all subsequent sampling events. If there is no validated detection for an analyte or method from the initial scheduled event(s) at the well, that analyte and/or method will be dropped from the analytical suite for the well for subsequent sampling events.

3.5.2.3 Aquifer Tubes

Table 3-3 summarizes aquifer tube activities. If possible, aquifer tubes should be advanced using direct-push methods. A set of three new aquifer tubes will be installed to multiple depths at one location in 100-D and at one location in 100-H. The depth of each aquifer tube screen will be based on previously collected aquifer tube and well data. Direct-push methods can be used to drive a casing with a screened lower end to provide for in situ probes and data loggers. Ideal positioning is near the seasonally

low-river-stage shoreline, for example, when the lowest anticipated mean river discharge occurs. Historically, the lowest anticipated river discharge is September through November.

Aquifer tube water samples will be collected for analysis during three sampling rounds to support the RI. The samples will be collected at the seasonal “low,” “high,” and “transition” river stages and analyzed for the COPCs and additional analytes listed in Table 1-2 in accordance with the performance requirements in Table 2-19.

Table 3-3. Aquifer Tube Sample/Measurement Locations and Depth

Sampling Location	Action	Water Chemistry	
		Sample Interval Depth	Analyte List
Three new aquifer tubes at one location in 100-D Area (Location No. 1) and three new aquifer tubes at one location in 100-H Area (Location No. 8).	Drive six new aquifer tubes to support RI.	Collect one sample per aquifer tube and sample three rounds to represent the low, high, and transition river stages.	Table 1-2 in accordance with Table 2-19. Field screening parameters in accordance with Table 2-19.
Total number of real samples:		18	
Minimum number of field quality control samples:*		9 (3 equipment blank, 3 field blank, 3 duplicate)	
Total number of samples:		27	
* Quality control samples for aquifer tube samples will be collected at a frequency of 1 equipment blank, 1 field blank, and 1 duplicate sample for each round of sampling (3 total rounds). A split sample will be collected in association with each round of groundwater sampling (aquifer tube and monitoring well) and has been included in the groundwater monitoring sample total.			

3.6 Sampling Methods

Soil/aquifer sediment sampling will be performed in accordance with approved procedures for soil and aquifer sediment sampling using a 10.2-cm (4-in.) split-spoon sampler. The split-spoon samplers will be equipped with separate stainless steel or polycarbonate liners. Site personnel will not overdrive the sampling device. Samples for VOCs will be packaged first. Next, the remaining soil/aquifer sediment will be transferred to a pre-cleaned, stainless steel mixing bowl or other suitable pre-cleaned container, homogenized, then containerized in accordance with the sampling procedure. If sample volume requirements cannot be met, samples will be collected according to the following consistent priority for all samples, as applicable: hexavalent chromium, metals (including mercury and uranium), tritium, nitrate, strontium-90, technetium-99, other radionuclides, PCBs, VOCs, other anions, batch leach test and physical properties. Sufficient volume should be available to perform these analyses.

Groundwater samples collected during drilling, before development, will be pumped from selected intervals. The pump will be operated long enough to provide stabilized field readings, but not necessarily three casing volumes.

For the spatial and temporal uncertainty groundwater monitoring well network, before sample capture, the pump will be operated for a period of time sufficient to provide stabilized field readings and at least three casing volumes. Groundwater sampling from completed wells will be performed to support the spatial and temporal uncertainty investigation in accordance with field sampling, sample handling, and documentation activities per HASQARD (DOE/RL-96-68) requirements. Samplers fill out groundwater

sample report forms during purging and sampling activities at each well. Field personnel measure water levels in each well before sampling and then purge stagnant water from the well. Water levels are typically measured with laminated-steel electrical sounding tapes with a precision of 2 mm. Procedures require sample collection after three casing volumes of water have been purged from the well and after field parameters (e.g., pH, temperature, specific conductance, and turbidity) have stabilized. Field parameters measured are listed in Table 2-19. Field parameters are typically measured in a flow-through container; however, when there is insufficient flow, samplers will measure field parameters in an open container. Both filtered and unfiltered samples are collected for metals analyses as listed in Table 3-1. Filtering is performed in the field to ensure that results represent dissolved metals and do not include particulates. Sample preservation techniques will follow generally accepted practices (e.g., EPA-approved guidelines such as SW-846, or equivalent) and will be documented on sample authorization forms generated by the Sample Management and Reporting organization. Identification of preliminary sample preservatives is presented in Table 3-5.

Aquifer tube samples will be grab samples collected using a pump with no purge before sample collection.

3.6.1 Corrective Actions and Deviations for Sampling Activities

The project lead, sampling lead, drilling lead, or designee must document deviations from procedures or other problems pertaining to sample collection, chain-of-custody, target analytes, COPCs, sample transport, or noncompliant monitoring. Examples of deviations include samples not collected because of field conditions, changes in sample locations because of physical obstructions, or additions of sample depth(s).

As appropriate, such deviations or problems will be documented in the field logbook or on nonconformance report forms in accordance with internal corrective action procedures. The project lead, sampling lead, drilling lead, or designee will be responsible for communicating field corrective action requirements and for ensuring immediate corrective actions are applied to field activities.

More significant changes in sample locations not affecting the data needs will require notification and approval of the project lead. Changes to sample locations resulting in impacts to meeting the data needs will require concurrence with DOE and regulatory project leads. Changes to the SAP will be documented as noted in Section 2.1.6.

3.6.2 Decontamination of Sampling and Drilling Equipment

Sampling equipment will be decontaminated in accordance with the sampling equipment decontamination procedure. To prevent contamination of the samples, care should be taken to use clean equipment for each sampling activity. Special care should be taken to avoid the following common ways in which cross-contamination or background contamination may compromise the samples:

- Improperly storing or transporting sampling equipment and sample containers.
- Contaminating the equipment or sample container by setting the equipment/sample container on or near potential contamination sources (e.g., uncovered ground).
- Handling bottles or equipment with dirty hands or gloves.
- Improperly decontaminating equipment before sampling or between sampling events. Field decontamination (e.g., field washing and reuse) is not appropriate for sampling equipment.

The drill rig derrick, all downhole equipment, and temporary casing will be field decontaminated (e.g., high pressure and temperature), at a minimum, before mobilization and demobilization at each drilling location.

3.6.3 Radiological Field Data

Alpha and beta/gamma data collection in the field will be used as needed to support sampling and analysis efforts. Generally, cuttings from boreholes (excluding slough) will be field screened for evidence of radiological contamination. Screening will be conducted visually and with field instruments. Radiological screening will be performed by the radiological control technician or other qualified personnel. The radiological control technician will record field measurements, noting the depth of the sample and the instrument reading. Measurements will be relayed to the field geologist for inclusion in the field logbook or operational records daily, as applicable.

The following information will be distributed to personnel performing work in support of this SAP:

- Instructions to radiological control technicians on the methods required to measure sample activity and media for gamma, alpha, and/or beta emissions, as appropriate.
- Information regarding the Geiger-Müller, portable alpha meter, dual phosphors beta/gamma, and sodium iodide portable instruments, will include a physical description of the instruments, radiation and energy response characteristics, calibration/maintenance and performance testing descriptions, and the application/operation of the instrument. These instruments are commonly used on the Hanford Site for obtaining measurements of removable surface contamination measurements and direct measurements of the total surface contamination.
- Information on the characteristics associated with the hand-held probes to be used in the performance of direct radiological measurements will include a physical description of the probe, the radiation and energy response characteristics, calibration/maintenance and performance testing descriptions, and the application/operation of the instrument. The hand-held probe is an alpha detection instrument commonly used on the Hanford Site for obtaining removable surface contamination measurements and direct measurements of the total surface contamination.

3.7 Sample Handling

Sample handling, including sample containers, container labeling, sample custody, and sample transportation, is discussed in this section.

3.7.1 Sample Containers

Level I EPA pre-cleaned sample containers will be used for soil/aquifer sediment and water samples collected for chemical analysis. Container sizes may vary depending on laboratory specific volumes and requirements for meeting analytical detection limits. Radiological Engineering will measure the contamination levels and dose rates associated with the sample containers. This information, along with other data, will be used to select proper packaging, marking, labeling, and shipping paperwork and to verify that the sample can be received by the analytical laboratory in accordance with the laboratory's acceptance criteria. If the dose rate on the outside of a sample container or the curie content exceeds levels acceptable by an offsite laboratory, the sampling lead, in consultation with Sample Management and Reporting, can send smaller volumes to the laboratory. Preliminary container types and volumes are identified in Tables 3-4 and 3-5.

Table 3-4. Sample Preservation, Container, and Holding Time for Soil/Aquifer Sediment Samples

Method	Preservation Requirement	Holding Time	Bottle Type	Minimum Sample Size ^a
Alpha energy analysis	None	6 months	G/P	5 g
Americium-241/Curium-244	None	6 months	G/P	5 g
Gamma energy analysis	None	6 months	G/P	750 g
Liquid scintillation counter	None	6 months	G	33 g
Isotopic – plutonium	None	6 months	G/P	5 g
Isotopic – uranium	None	6 months	G/P	5 g
Strontium-90	None	6 months	G/P	5 g
Gas flow proportional counting	None	6 months	G/P	5 g
EPA 6010	Cool ~4° C	6 months	G/P	15 g
EPA 7196	Cool ~4° C	30 days	G/P	50 g
EPA 7471	None	28 days	G/P	15 g
UKPA	None	6 months	G/P	10 g
EPA 8082	Cool ~4° C	14/40 days	aG	50 g
EPA 8260 ^b	Cool ~4° C	14 days	G	50 g
EPA 300.0	Cool ~4° C	48 hours/28 days	G/P	50 g
EPA 9012	None	14 days	G/P	50 g
ASTM D2216	None	None	Moisture-proof container	200 g
ASTM D2937	None	None	G/P	1,000 g
ASTM D2434	None	None	P	1,000 g
ASTM D5084	None	None	P	1,000 g
Batch leaching test	Cool ~4° C	28 days from field to extraction	G	100 g/120 mL Each sample from the 100-D-12 French Drain will be collected in a lined 5-gallon bucket.
Distribution coefficient	Cool ~4° C		Moisture-proof container	250 g

Table 3-4. Sample Preservation, Container, and Holding Time for Soil/Aquifer Sediment Samples

Method	Preservation Requirement	Holding Time	Bottle Type	Minimum Sample Size ^a
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Notes:

a. Based on minimum quality control requirements.

b. Field preservation, EPA Method 5035A, also may be used.

For EPA Method 300.0, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*.

For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.

ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*.

ASTM D2434-68, *Standard Test Method for Permeability of Granular Soils (Constant Head)*.

ASTM D2937-04, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method*.

ASTM D5084-03, *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*.

48 hours/28 days = 48 hours for nitrate, nitrite, and phosphate; others, 28 days

14/40 days = 14 days to extraction, then 40 days to analysis

aG = amber glass

G = glass

P = plastic

UKPA = total uranium by kinetic phosphorescence analysis

Table 3-5. Sample Preservation, Container, and Holding Time for Water Samples

Method	Preservation Requirement	Holding Time	Bottle Type	Minimum Sample Size*
Strontium-90	HNO ₃ to pH <2	6 months	G/P	2,000 mL
LSC - Technetium-99	HCl to pH <2	6 months	G/P	1,000 mL
EPA 6020 or 200.8	HNO ₃ to pH <2	6 months	G/P	300 mL
LSC - Tritium	None	6 months	G	60 mL
EPA 6010	HNO ₃ to pH <2	6 months	G/P	300 mL
EPA 7196	Cool ~4° C	24 hours	aG	500 mL
EPA 7470 or 200.8	HNO ₃ to pH <2	28 Days	G	500 mL
Total uranium (chemical)	HNO ₃ to pH <2	6 months	G/P	500 mL
EPA 8260	Cool ~4° C, HCl or H ₂ SO ₄ to pH <2	14 days	aGs	40 mL
EPA 8270	None	7 days/40 days	aG	1,000 mL
EPA 8310	None	14 days/40 days	aG	1,000 mL
EPA 8081	None	7 days/40 days	aG	1,000 mL

Table 3-5. Sample Preservation, Container, and Holding Time for Water Samples

Method	Preservation Requirement	Holding Time	Bottle Type	Minimum Sample Size*
EPA 8082	None	7 days/40 days	aG	1,000 mL
EPA 1668A	None	7 days/40 days	aG	1,000 mL
EPA 9012	NaOH to pH ≥ 12	14 days	G/P	500 mL
EPA 300.0	Cool $\sim 4^{\circ}\text{C}$	48 hours/28 days	P	125 mL

Notes:

* Based on minimum QC requirements.

For EPA Method 200.8, see EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*.

For EPA Method 300.0, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*.

For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.

14 days/40 days = 14 days from sample collection to extraction; 40 days from extraction to analysis

7 days/40 days = 7 days from sample collection to extraction; 40 days from extraction to analysis

48 hours/28 days = 48 hours for nitrate, nitrite, and phosphate; others, 28 days

aG = amber glass

aGs = amber glass septum; no headspace

G = glass

P = plastic

3.7.2 Container Labeling

The sample location, depth, and corresponding HEIS number are documented in the sampler's field logbook. A custody seal (e.g., evidence tape) is affixed to each sample container and/or the sample collection package in such a way as to indicate potential tampering. Each sample container will be labeled with the following information on firmly affixed, water-resistant labels:

- HEIS number
- Sample collection date and time
- Analysis required
- Preservation method (if applicable)
- Sampling authorization form number

In addition to the above information, sample records must include the following:

- Analysis required
- Source of sample
- Matrix
- Field data (pH, radiological readings)

Except for VOC samples, a custody seal (i.e., evidence tape) will be affixed to the lid of each sample container. The custody seal will be inscribed with the sampler's initials and the date. Custody seals are

not applied directly to VOC sample vials because of a potential for affecting analytical results and/or fouling of laboratory equipment. Custody seals and any other required labels or documentation can be fixed to the exterior of a plastic bag holding the vials in such a manner to detect potential tampering.

3.7.3 Sample Custody Requirements

Sample custody will be maintained in accordance with existing Hanford Site protocols to maintain sample integrity throughout the analytical process. Chain-of-custody procedures will be followed throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained.

A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each set of samples shipped to the laboratory. Shipping requirements will determine how sample shipping containers are prepared for shipment. The analyses requested for each sample will be indicated on the accompanying chain-of-custody form. Each time the responsibility changes for the custody of the sample, the new and previous sample custodians will sign the record and note the date and time. The sampler will make a copy of the signed record before sample shipment and will transmit the copy to Sample Management and Reporting within 48 hours of shipping.

The following information is required on a completed chain-of-custody form:

- Project name
- Signature of sampler
- Unique sample number
- Date and time of collection
- Matrix
- Preservatives
- Signatures of individual involved in sample transfer
- Requested analyses or reference thereto

3.7.4 Sample Transportation

Sample transportation will be in compliance with the applicable regulations for packaging, marking, labeling, and shipping hazardous materials, hazardous substances, and hazardous waste mandated by the U.S. Department of Transportation (49 CFR 171, “General Information, Regulations, and Definitions,” through Part 177, “Carriage by Public Highway”) in association with the International Air Transportation Authority, DOE requirements, and applicable program specific implementing procedures.

3.8 Management of Waste

All waste (including unexpected waste) generated by sampling activities will be managed in accordance with DOE/RL-97-01, *Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Units*. Pursuant to 40 CFR 300.440, “National Oil and Hazardous Substances Pollution Contingency Plan,” “Procedures for Planning and Implementing Off-Site Response Actions,” approval from DOE-RL Remedial Project Manager is required before returning unused samples or waste from offsite laboratories.

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4 Health and Safety

Field operations will be performed in accordance with health and safety requirements and appropriate Soil and Groundwater Remediation Project requirements. Additionally, work control documents will be prepared to control site operations further. Safety documentation will include an activity hazard analysis and, as applicable, radiological work permits. The sampling procedures and associated activities will implement ALARA practices to minimize the radiation exposure to the sampling team, consistent with the requirements defined in 10 CFR 835.

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5 References

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Appendix A

Analyte Lists for Methods-Based Analyses

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A1 Analyte Lists for Methods-Based Analyses

Tables A-1 through A-13 provide lists of analytes that will be reported when using a methods-based approach. Based on this approach, strontium-90, technetium-99, tritium, hexavalent chromium, mercury, and total uranium are not listed as they are single analyte methods.

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Table A-1. U.S. Environmental Protection Agency Method 300.0

Chemical Abstracts Service Number	Constituent	Water Estimated Quantitation Limit (µg/L)	Soil Estimated Quantitation Limit (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
24959-67-9	Bromide	250	2,500	≤20 / ≤30	80-120 / 70-130
16887-00-6	Chloride	200	2,000	≤20 / ≤30	80-120 / 70-130
16984-48-8	Fluoride	500	5,000	≤20 / ≤30	80-120 / 70-130
14797-55-8	Nitrate*	250	2,500	≤20 / ≤30	80-120 / 70-130
14797-65-0	Nitrite*	250	2,500	≤20 / ≤30	80-120 / 70-130
NO3-N	Nitrogen in nitrate*	75	750	≤20 / ≤30	80-120 / 70-130
NO2-N	Nitrogen in nitrite*	75	750	≤20 / ≤30	80-120 / 70-130
14265-44-2	Phosphate	500	5,000	≤20 / ≤30	80-120 / 70-130
14808-79-8	Sulfate	500	5,000	≤20 / ≤30	80-120 / 70-130

Notes:

* May be reported as Nitrate and Nitrite, or Nitrogen in nitrate and Nitrogen in nitrite.

EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*.

µg/L = micrograms per liter

µg/kg = micrograms per kilogram

Table A-2. U.S. Environmental Protection Agency SW-846 Method 6010

Chemical Abstracts Service Number	Constituent	Water Estimated Quantitation Limit (µg/L)	Soil Estimated Quantitation Limit (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
7429-90-5	Aluminum	50	5,000	≤20 / ≤30	80-120 / 70-130
7440-36-0	Antimony	60	6,000	≤20 / ≤30	80-120 / 70-130
7440-38-2	Arsenic	100	10,000	≤20 / ≤30	80-120 / 70-130
7440-39-3	Barium	20	2,000	≤20 / ≤30	80-120 / 70-130
7440-41-7	Beryllium	2	500	≤20 / ≤30	80-120 / 70-130
7440-69-9	Bismuth	100	10,000	≤20 / ≤30	80-120 / 70-130
7440-42-8	Boron	20	2,000	≤20 / ≤30	80-120 / 70-130
7440-43-9	Cadmium	2	500	≤20 / ≤30	80-120 / 70-130
7440-70-2	Calcium	1,000	100,000	≤20 / ≤30	80-120 / 70-130
7440-47-3	Chromium	10	1,000	≤20 / ≤30	80-120 / 70-130
7440-48-4	Cobalt	20	2,000	≤20 / ≤30	80-120 / 70-130
7440-50-8	Copper	8	1,000	≤20 / ≤30	80-120 / 70-130
7439-89-6	Iron	50	5,000	≤20 / ≤30	80-120 / 70-130
7439-92-1	Lead	50	5,000	≤20 / ≤30	80-120 / 70-130
7439-93-2	Lithium	25	2,500	≤20 / ≤30	80-120 / 70-130
7439-95-4	Magnesium	750	75,000	≤20 / ≤30	80-120 / 70-130
7439-96-5	Manganese	5	5,000	≤20 / ≤30	80-120 / 70-130
7439-98-7	Molybdenum	20	2,000	≤20 / ≤30	80-120 / 70-130
7440-02-0	Nickel	40	4,000	≤20 / ≤30	80-120 / 70-130
7440-09-7	Potassium	4,000	400,000	≤20 / ≤30	80-120 / 70-130
7782-49-2	Selenium	100	10,000	≤20 / ≤30	80-120 / 70-130
7440-21-3	Silicon	20	2,000	≤20 / ≤30	80-120 / 70-130
7440-22-4	Silver	10	1,000	≤20 / ≤30	80-120 / 70-130
7440-23-5	Sodium	500	50,000	≤20 / ≤30	80-120 / 70-130
7440-24-6	Strontium	10	1,000	≤20 / ≤30	80-120 / 70-130
7440-28-0	Thallium	50	5,000	≤20 / ≤30	80-120 / 70-130
7440-31-5	Tin	100	10,000	≤20 / ≤30	80-120 / 70-130
7440-62-2	Vanadium	25	2,500	≤20 / ≤30	80-120 / 70-130
7440-66-6	Zinc	10	1,000	≤20 / ≤30	80-120 / 70-130

Notes:

SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*

µg/L = micrograms per liter

µg/kg = micrograms per kilogram

Table A-3. U.S. Environmental Protection Agency Method 200.8 or SW-846 Method 6020

Chemical Abstracts Service Number	Constituent	Water Estimated Quantitation Limit (µg/L)	Soil Estimated Quantitation Limit (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
7440-36-0	Antimony	5	600	≤20 / ≤30	80-120 / 70-130
7440-38-2	Arsenic	4	1,000	≤20 / ≤30	80-120 / 70-130
7440-39-3	Barium	5	500	≤20 / ≤30	80-120 / 70-130
7440-41-7	Beryllium	2	200	≤20 / ≤30	80-120 / 70-130
7440-43-9	Cadmium	2	200	≤20 / ≤30	80-120 / 70-130
7440-47-3	Chromium	2	200	≤20 / ≤30	80-120 / 70-130
7439-92-1	Lead	2	500	≤20 / ≤30	80-120 / 70-130
7782-49-2	Selenium	4	1,000	≤20 / ≤30	80-120 / 70-130
7440-22-4	Silver	2	200	≤20 / ≤30	80-120 / 70-130
7440-28-0	Thallium	2	500	≤20 / ≤30	80-120 / 70-130

Notes:

SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*For EPA Method 200.8, see EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*.

µg/L = micrograms per liter

µg/kg = micrograms per kilogram

Table A-4. U.S. Environmental Protection Agency SW-846 Method 8081

Chemical Abstracts Service Number	Constituent	Water Estimated Quantitation Limit (µg/L)	Soil Estimated Quantitation Limit (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
72-54-8	4,4'-DDD	0.1	3.3	≤20 / ≤30	80-120 / 70-130
72-55-9	4,4'-DDE	0.1	3.3	≤20 / ≤30	80-120 / 70-130
50-29-3	4,4'-DDT	0.1	3.3	≤20 / ≤30	80-120 / 70-130
309-00-2	Aldrin	0.05	1.65	≤20 / ≤30	80-120 / 70-130
319-84-6	Alpha-BHC	0.05	1.65	≤20 / ≤30	80-120 / 70-130
5103-71-9	alpha-Chlordane	0.5	16.5	≤20 / ≤30	80-120 / 70-130
319-85-7	Beta-BHC	0.05	1.65	≤20 / ≤30	80-120 / 70-130
57-74-9	Chlordane	0.5	16.5	≤20 / ≤30	80-120 / 70-130
319-86-8	Delta-BHC	0.05	1.65	≤20 / ≤30	80-120 / 70-130

Table A-4. U.S. Environmental Protection Agency SW-846 Method 8081

Chemical Abstracts Service Number	Constituent	Water Estimated Quantitation Limit (µg/L)	Soil Estimated Quantitation Limit (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
60-57-1	Dieldrin	0.05	3.3	≤20 / ≤30	80-120 / 70-130
959-98-8	Endosulfan I	0.05	1.65	≤20 / ≤30	80-120 / 70-130
33213-65-9	Endosulfan II	0.1	3.3	≤20 / ≤30	80-120 / 70-130
1031-07-8	Endosulfan sulfate	0.1	3.3	≤20 / ≤30	80-120 / 70-130
72-20-8	Endrin	0.1	3.3	≤20 / ≤30	80-120 / 70-130
7421-93-4	Endrin aldehyde	0.1	3.3	≤20 / ≤30	80-120 / 70-130
53494-70-5	Endrin ketone	0.1	3.3	≤20 / ≤30	80-120 / 70-130
58-89-9	Gamma-BHC (Lindane)	0.05	1.65	≤20 / ≤30	80-120 / 70-130
76-44-8	Heptachlor	0.05	1.65	≤20 / ≤30	80-120 / 70-130
1024-57-3	Heptachlor epoxide	0.05	1.65	≤20 / ≤30	80-120 / 70-130
72-43-5	Methoxychlor	0.5	16.5	≤20 / ≤30	80-120 / 70-130
8001-35-2	Toxaphene	2	165	≤20 / ≤30	80-120 / 70-130
5103-74-2	trans-Chlordane	0.5	16.5	≤20 / ≤30	80-120 / 70-130

Notes:

SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*

4,4'-DDD = Dichlorodiphenyldichloroethane

4,4'-DDE = Dichlorodiphenyldichloroethylene

4,4'-DDT = Dichlorodiphenyltrichloroethane

BHC = Benzenehexachloride

µg/L = micrograms per liter

µg/kg = micrograms per kilogram

Table A-5. U.S. Environmental Protection Agency SW-846 Method 8082

Chemical Abstracts Service Number	Constituent	Water Estimated Quantitation Limit (µg/L)	Soil Estimated Quantitation Limit (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
12674-11-2	Aroclor-1016	0.5	16.5	≤20 / ≤30	80-120 / 70-130
11104-28-2	Aroclor-1221	0.5	16.5	≤20 / ≤30	80-120 / 70-130
11141-16-5	Aroclor-1232	0.5	16.5	≤20 / ≤30	80-120 / 70-130

Table A-5. U.S. Environmental Protection Agency SW-846 Method 8082

Chemical Abstracts Service Number	Constituent	Water Estimated Quantitation Limit (µg/L)	Soil Estimated Quantitation Limit (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
53469-21-9	Aroclor-1242	0.5	16.5	≤20 / ≤30	80-120 / 70-130
12672-29-6	Aroclor-1248	0.5	16.5	≤20 / ≤30	80-120 / 70-130
11097-69-1	Aroclor-1254	0.5	16.5	≤20 / ≤30	80-120 / 70-130
11096-82-5	Aroclor-1260	0.5	16.5	≤20 / ≤30	80-120 / 70-130
37324-23-5	Aroclor-1262	0.5	16.5	≤20 / ≤30	80-120 / 70-130
11100-14-4	Aroclor-1268	0.5	16.5	≤20 / ≤30	80-120 / 70-130

Notes:

SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*

µg/L = micrograms per liter

µg/kg = micrograms per kilogram

Table A-6. U.S. Environmental Protection Agency SW-846 Method 8260

Chemical Abstracts Service Number	Constituent	Water Estimated Quantitation Limit (µg/L)	Soil Estimated Quantitation Limit (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
71-55-6	1,1,1-Trichloroethane	5	5	≤20 / ≤30	80-120 / 70-130
79-34-5	1,1,2,2-Tetrachloroethane	5	5	≤20 / ≤30	80-120 / 70-130
79-00-5	1,1,2-Trichloroethane	2	5	≤20 / ≤30	80-120 / 70-130
75-34-3	1,1-Dichloroethane	2	10	≤20 / ≤30	80-120 / 70-130
75-35-4	1,1-Dichloroethene	10	10	≤20 / ≤30	80-120 / 70-130
107-06-2	1,2-Dichloroethane	5	5	≤20 / ≤30	80-120 / 70-130
540-59-0	1,2-Dichloroethene (total)	10	10	≤20 / ≤30	80-120 / 70-130
78-87-5	1,2-Dichloropropane	5	5	≤20 / ≤30	80-120 / 70-130
78-93-3	2-Butanone	10	10	≤20 / ≤30	80-120 / 70-130
591-78-6	2-Hexanone	20	20	≤20 / ≤30	80-120 / 70-130
108-10-1	4-Methyl-2-pentanone	10	10	≤20 / ≤30	80-120 / 70-130
67-64-1	Acetone	20	20	≤20 / ≤30	80-120 / 70-130
71-43-2	Benzene	1.5	5	≤20 / ≤30	80-120 / 70-130
75-27-4	Bromodichloromethane	5	5	≤20 / ≤30	80-120 / 70-130

Table A-6. U.S. Environmental Protection Agency SW-846 Method 8260

Chemical Abstracts Service Number	Constituent	Water Estimated Quantitation Limit (µg/L)	Soil Estimated Quantitation Limit (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
75-25-2	Bromoform	5	5	≤20 / ≤30	80-120 / 70-130
74-83-9	Bromomethane	10	10	≤20 / ≤30	80-120 / 70-130
75-15-0	Carbon disulfide	5	5	≤20 / ≤30	80-120 / 70-130
56-23-5	Carbon tetrachloride	2	5	≤20 / ≤30	80-120 / 70-130
108-90-7	Chlorobenzene	5	5	≤20 / ≤30	80-120 / 70-130
75-00-3	Chloroethane	10	10	≤20 / ≤30	80-120 / 70-130
67-66-3	Chloroform	5	5	≤20 / ≤30	80-120 / 70-130
74-87-3	Chloromethane	10	10	≤20 / ≤30	80-120 / 70-130
156-59-2	cis-1,2-Dichloroethylene	5	5	≤20 / ≤30	80-120 / 70-130
10061-01-5	cis-1,3-Dichloropropene	5	5	≤20 / ≤30	80-120 / 70-130
124-48-1	Dibromochloromethane	5	5	≤20 / ≤30	80-120 / 70-130
100-41-4	Ethylbenzene	5	5	≤20 / ≤30	80-120 / 70-130
75-09-2	Methylene chloride	5	5	≤20 / ≤30	80-120 / 70-130
100-42-5	Styrene	5	5	≤20 / ≤30	80-120 / 70-130
127-18-4	Tetrachloroethene	5	5	≤20 / ≤30	80-120 / 70-130
108-88-3	Toluene	5	5	≤20 / ≤30	80-120 / 70-130
156-60-5	trans-1,2-Dichloroethylene	5	5	≤20 / ≤30	80-120 / 70-130
10061-02-6	trans-1,3-Dichloropropene	5	5	≤20 / ≤30	80-120 / 70-130
79-01-6	Trichloroethene	2	5	≤20 / ≤30	80-120 / 70-130
75-01-4	Vinyl chloride	5	5	≤20 / ≤30	80-120 / 70-130
1330-20-7	Xylenes (total)	10	10	≤20 / ≤30	80-120 / 70-130

Notes:

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µg/L = micrograms per liter

µg/kg = micrograms per kilogram

Table A-7. U.S. Environmental Protection Agency (EPA) SW-846 Method 8270

Chemical Abstracts Service Number	Constituent	Water Estimated Quantitation Limit (µg/L)	Soil Estimated Quantitation Limit (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
120-82-1	1,2,4-Trichlorobenzene	10	330	≤20 / ≤30	80-120 / 70-130
95-50-1	1,2-Dichlorobenzene	10	330	≤20 / ≤30	80-120 / 70-130
541-73-1	1,3-Dichlorobenzene	10	330	≤20 / ≤30	80-120 / 70-130
106-46-7	1,4-Dichlorobenzene	5	330	≤20 / ≤30	80-120 / 70-130
95-95-4	2,4,5-Trichlorophenol	10	330	≤20 / ≤30	80-120 / 70-130
88-06-2	2,4,6-Trichlorophenol	10	330	≤20 / ≤30	80-120 / 70-130
120-83-2	2,4-Dichlorophenol	10	330	≤20 / ≤30	80-120 / 70-130
105-67-9	2,4-Dimethylphenol	10	330	≤20 / ≤30	80-120 / 70-130
51-28-5	2,4-Dinitrophenol	25	825	≤20 / ≤30	80-120 / 70-130
121-14-2	2,4-Dinitrotoluene	10	330	≤20 / ≤30	80-120 / 70-130
606-20-2	2,6-Dinitrotoluene	10	330	≤20 / ≤30	80-120 / 70-130
91-58-7	2-Chloronaphthalene	10	330	≤20 / ≤30	80-120 / 70-130
95-57-8	2-Chlorophenol	10	330	≤20 / ≤30	80-120 / 70-130
91-57-6	2-Methylnaphthalene	10	330	≤20 / ≤30	80-120 / 70-130
95-48-7	2-Methylphenol (cresol, o-)	10	330	≤20 / ≤30	80-120 / 70-130
88-74-4	2-Nitroaniline	10	330	≤20 / ≤30	80-120 / 70-130
88-75-5	2-Nitrophenol	20	660	≤20 / ≤30	80-120 / 70-130
91-94-1	3,3'-Dichlorobenzidine	10	330	≤20 / ≤30	80-120 / 70-130
65794-96-9	3+4 Methylphenol (cresol, m+p)	10	330	≤20 / ≤30	80-120 / 70-130
99-09-2	3-Nitroaniline	10	330	≤20 / ≤30	80-120 / 70-130
534-52-1	4,6-Dinitro-2-methylphenol	10	330	≤20 / ≤30	80-120 / 70-130
101-55-3	4-Bromophenylphenyl ether	10	330	≤20 / ≤30	80-120 / 70-130
59-50-7	4-Chloro-3-methylphenol	10	330	≤20 / ≤30	80-120 / 70-130
106-47-8	4-Chloroaniline	10	330	≤20 / ≤30	80-120 / 70-130
7005-72-3	4-Chlorophenylphenyl ether	10	330	≤20 / ≤30	80-120 / 70-130
100-01-6	4-Nitroaniline	10	330	≤20 / ≤30	80-120 / 70-130
100-02-7	4-Nitrophenol	20	660	≤20 / ≤30	80-120 / 70-130
83-32-9	Acenaphthene	10	330	≤20 / ≤30	80-120 / 70-130
208-96-8	Acenaphthylene	10	330	≤20 / ≤30	80-120 / 70-130

Table A-7. U.S. Environmental Protection Agency (EPA) SW-846 Method 8270

Chemical Abstracts Service Number	Constituent	Water Estimated Quantitation Limit (µg/L)	Soil Estimated Quantitation Limit (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
120-12-7	Anthracene	10	330	≤20 / ≤30	80-120 / 70-130
56-55-3	Benzo(a)anthracene	10	330	≤20 / ≤30	80-120 / 70-130
50-32-8	Benzo(a)pyrene	10	330	≤20 / ≤30	80-120 / 70-130
205-99-2	Benzo(b)fluoranthene	10	330	≤20 / ≤30	80-120 / 70-130
191-24-2	Benzo(ghi)perylene	10	330	≤20 / ≤30	80-120 / 70-130
207-08-9	Benzo(k)fluoranthene	10	330	≤20 / ≤30	80-120 / 70-130
108-60-1	Bis(2-chloro-1-methylethyl) ether	10	330	≤20 / ≤30	80-120 / 70-130
111-91-1	Bis(2-Chloroethoxy)methane	10	330	≤20 / ≤30	80-120 / 70-130
111-44-4	Bis(2-chloroethyl) ether	10	330	≤20 / ≤30	80-120 / 70-130
117-81-7	Bis(2-ethylhexyl) phthalate	10	330	≤20 / ≤30	80-120 / 70-130
85-68-7	Butylbenzylphthalate	10	330	≤20 / ≤30	80-120 / 70-130
86-74-8	Carbazole	10	330	≤20 / ≤30	80-120 / 70-130
218-01-9	Chrysene	10	330	≤20 / ≤30	80-120 / 70-130
53-70-3	Dibenz[a,h]anthracene	10	330	≤20 / ≤30	80-120 / 70-130
132-64-9	Dibenzofuran	10	330	≤20 / ≤30	80-120 / 70-130
84-66-2	Diethylphthalate	10	330	≤20 / ≤30	80-120 / 70-130
131-11-3	Dimethyl phthalate	10	330	≤20 / ≤30	80-120 / 70-130
84-74-2	Di-n-butylphthalate	10	330	≤20 / ≤30	80-120 / 70-130
117-84-0	Di-n-octylphthalate	10	330	≤20 / ≤30	80-120 / 70-130
206-44-0	Fluoranthene	10	330	≤20 / ≤30	80-120 / 70-130
86-73-7	Fluorene	10	330	≤20 / ≤30	80-120 / 70-130
118-74-1	Hexachlorobenzene	10	330	≤20 / ≤30	80-120 / 70-130
87-68-3	Hexachlorobutadiene	10	330	≤20 / ≤30	80-120 / 70-130
77-47-4	Hexachlorocyclopentadiene	10	330	≤20 / ≤30	80-120 / 70-130
67-72-1	Hexachloroethane	10	330	≤20 / ≤30	80-120 / 70-130
193-39-5	Indeno(1,2,3-cd)pyrene	10	330	≤20 / ≤30	80-120 / 70-130
78-59-1	Isophorone	10	330	≤20 / ≤30	80-120 / 70-130
91-20-3	Naphthalene	10	330	≤20 / ≤30	80-120 / 70-130
98-95-3	Nitrobenzene	10	330	≤20 / ≤30	80-120 / 70-130

Table A-7. U.S. Environmental Protection Agency (EPA) SW-846 Method 8270

Chemical Abstracts Service Number	Constituent	Water Estimated Quantitation Limit (µg/L)	Soil Estimated Quantitation Limit (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
621-64-7	n-Nitrosodi-n-dipropylamine	10	330	≤20 / ≤30	80-120 / 70-130
86-30-6	n-Nitrosodiphenylamine	10	330	≤20 / ≤30	80-120 / 70-130
87-86-5	Pentachlorophenol	10	330	≤20 / ≤30	80-120 / 70-130
85-01-8	Phenanthrene	10	330	≤20 / ≤30	80-120 / 70-130
108-95-2	Phenol	10	330	≤20 / ≤30	80-120 / 70-130
129-00-0	Pyrene	10	330	≤20 / ≤30	80-120 / 70-130

Notes:

* May report as 3-Methylphenol (cresol, p-) and 4-Methylphenol (cresol, m-) or a 3+4 Methylphenol (cresol, m+p) total.

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µg/L = micrograms per liter

µg/kg = micrograms per kilogram

Table A-8. U.S. Environmental Protection Agency SW-846 Method 8310

Chemical Abstracts Service Number	Constituent	Water Estimated Quantitation Limit (µg/L)	Soil Estimated Quantitation Limit (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
83-32-9	Acenaphthene	20	100	≤20 / ≤30	80-120 / 70-130
208-96-8	Acenaphthylene	25	100	≤20 / ≤30	80-120 / 70-130
120-12-7	Anthracene	10	50	≤20 / ≤30	80-120 / 70-130
56-55-3	Benzo(a)anthracene	0.3	15	≤20 / ≤30	80-120 / 70-130
50-32-8	Benzo(a)pyrene	0.5	15	≤20 / ≤30	80-120 / 70-130
205-99-2	Benzo(b)fluoranthene	0.5	15	≤20 / ≤30	80-120 / 70-130
191-24-2	Benzo(ghi)perylene	1	30	≤20 / ≤30	80-120 / 70-130
207-08-9	Benzo(k)fluoranthene	0.5	15	≤20 / ≤30	80-120 / 70-130
218-01-9	Chrysene	5	100	≤20 / ≤30	80-120 / 70-130
53-70-3	Dibenz[a,h]anthracene	1	30	≤20 / ≤30	80-120 / 70-130
206-44-0	Fluoranthene	5	50	≤20 / ≤30	80-120 / 70-130
86-73-7	Fluorene	3	30	≤20 / ≤30	80-120 / 70-130
193-39-5	Indeno(1,2,3-cd)pyrene	1	30	≤20 / ≤30	80-120 / 70-130

Table A-8. U.S. Environmental Protection Agency SW-846 Method 8310

Chemical Abstracts Service Number	Constituent	Water Estimated Quantitation Limit (µg/L)	Soil Estimated Quantitation Limit (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
91-20-3	Naphthalene	20	100	≤20 / ≤30	80-120 / 70-130
85-01-8	Phenanthrene	10	50	≤20 / ≤30	80-120 / 70-130
129-00-0	Pyrene	5	50	≤20 / ≤30	80-120 / 70-130

Notes:

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µg/L = micrograms per liter

µg/kg = micrograms per kilogram

Table A-9. U.S. Environmental Protection Agency SW-846 Method 1668A

Chemical Abstracts Service Number	Constituent	Water Estimated Quantitation Limit (µg/L)	Precision Requirement Water (%)	Accuracy Requirement Water (%)
Varies	PCB Congeners*	0.02	≤20	80-120

Notes:

* There are 209 PCB congeners that may be identified using this analytical method, including the nine PCB congeners listed for Method 8082 (Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268), above. The CAS numbers and constituent names will vary by congener; however, the precision and accuracy requirements are not congener-specific.

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PCB = polychlorinated biphenyls

µg/L = micrograms per liter

Table A-10. Gamma Spectroscopy, Germanium High-Energy Detectors (Gamma Energy Analysis)

Chemical Abstracts Service Number	Constituent	Water Estimated Quantitation Limit ^a (pCi/L)	Soil Estimated Quantitation Limit ^a (pCi/g)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
14234-35-6	Antimony-125	50	0.3	≤30	70-130
13966-02-4	Beryllium-7	50	0.3	≤30	70-130
13967-70-9	Cesium-134	15	0.1	≤30	70-130
10045-97-3	Cesium-137	15	0.1	≤30	70-130

Table A-10. Gamma Spectroscopy, Germanium High-Energy Detectors (Gamma Energy Analysis)

Chemical Abstracts Service Number	Constituent	Water Estimated Quantitation Limit ^a (pCi/L)	Soil Estimated Quantitation Limit ^a (pCi/g)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
10198-40-0	Cobalt-60	25	0.05	≤30	70-130
14683-23-9	Europium-152	50	0.1	≤30	70-130
15585-10-1	Europium-154	50	0.1	≤30	70-130
14391-16-3	Europium-155	50	0.1	≤30	70-130
13966-00-2	Potassium-40			≤30	70-130
13967-48-1	Ruthenium-106			≤30	70-130

Notes:

a. Where EQL is not specified, the EQLs attainable by the laboratories for the methods-based constituents using the same analytical conditions as for the contaminants of concern are applicable.

pCi/L = picocuries per liter

pCi/g = picocuries per gram

Table A-11. Isotopic Uranium

Chemical Abstracts Service Number	Constituent	Water Estimated Quantitation Limit (pCi/L)	Soil Estimated Quantitation Limit (pCi/g)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
13966-29-5	Uranium-234	1	1	≤30	70-130
15117-96-1	Uranium-235	1	0.5	≤30	70-130
U-238	Uranium-238	1	1	≤30	70-130

Notes:

pCi/L = picocuries per liter

pCi/g = picocuries per gram

Table A-12. Plutonium

Chemical Abstracts Service Number	Constituent	Water Estimated Quantitation Limit (pCi/L)	Soil Estimated Quantitation Limit (pCi/g)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
13981-16-3	Plutonium-238	1	1	≤30	70-130
PU-239/240	Plutonium-239/240	1	1	≤30	70-130

Notes:

pCi/L = picocuries per liter

pCi/g = picocuries per gram

Table A-13. Gross Alpha/Beta by Gas Proportional Flow Counting Method 900.0

Chemical Abstracts Service Number	Constituent	Water Estimated Quantitation Limit (pCi/L)	Soil Estimated Quantitation Limit (pCi/g)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
12587-46-1	Gross Alpha Activity	3	NA	≤30	70-130
12587-47-2	Gross Beta Activity	4	NA	≤30	70-130

Notes:

NA = not applicable

pCi/L = picocuries per liter

pCi/g = picocuries per gram

Appendix B

Soil/Aquifer Sediment Target Analyte Development Documents

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Soil/Aquifer Sediment Target Analyte Development Documents

Following is the list of documents used to develop Appendix A, the 100-D/H soil/aquifer sediment target analyte lists:

1. BHI-00127, 1995, *100-H Area Technical Baseline Report, Rev 00*, Bechtel Hanford, Inc., Richland, Washington. Available at: <http://www5.hanford.gov/arpir/?content=findpage&AKey=D196035437>.
2. BHI-00932, 1996, *1996 Phase II Soil Sampling at the 183-H Solar Evaporation Basin Site*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at: <http://www5.hanford.gov/arpir/?content=findpage&AKey=D197143038>.
3. Capron, J.M., 2008, "116-N-1 CVP Rev. 1" (electronic memorandum to D.L. DeJong), Washington Closure Hanford, LLC, Richland, Washington.
4. CVP-2000-00001, 2000, *Cleanup Verification Package for the 100-D-18 Sludge Trench*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at: <http://www5.hanford.gov/arpir/?content=findpage&AKey=D8503416>.
5. CVP-2000-00002, 2000, *Cleanup Verification Package for the 116-DR-1&2 Process Effluent Trenches*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at: <http://www5.hanford.gov/arpir/?content=findpage&AKey=D8503376>.
6. CVP-2000-00003, 2001, *Cleanup Verification Package for the D and DR Group 2 North Pipelines (100-D-48:1/49:1), 100-D-19 Sludge Trench, and UPR-100-D-4 Unplanned Release Site*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at: <http://www5.hanford.gov/arpir/?content=findpage&AKey=D8723439>.
7. CVP-2000-00004, 2000, *Cleanup Verification Package for the 1607-D2 Septic Pipelines*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at: <http://www5.hanford.gov/arpir/?content=findpage&AKey=D8504445>.
8. CVP-2000-00005, 2000, *Cleanup Verification Package for the D and DR Group 2 Pipelines (100-D-48:2/49:2) and Unplanned Release Sites (UPR-100-D-2 and UPR-100-D-3)*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at: <http://www5.hanford.gov/arpir/?content=findpage&AKey=D8504424>.
9. CVP-2000-00008, 2000, *Cleanup Verification Package for the 116-D-4 Crib*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at: <http://www5.hanford.gov/arpir/?content=findpage&AKey=D5623021>.
10. CVP-2000-00009, 2000, *Cleanup Verification Package for the 116-D-6 French Drain*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at: <http://www5.hanford.gov/arpir/?content=findpage&AKey=D8565673>.
11. CVP-2000-00010, 2001, *Cleanup Verification Package for the 116-D-1A/116-D-1B Storage Basin Trenches and 100-D-46 Burial Ground*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at: <http://www5.hanford.gov/arpir/?content=findpage&AKey=D8686320>.
12. CVP-2000-00012, 2001, *Cleanup Verification Package for the 116-D-9 Crib and Pipeline*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at: <http://www5.hanford.gov/arpir/?content=findpage&AKey=D8686865>.

13. CVP-2000-00013, 2000, *Cleanup Verification Package for the 116-D-2 Pluto Crib*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at:
<http://www5.hanford.gov/arpir/?content=findpage&AKey=D5623125>.
14. CVP-2000-00014, 2000, *Cleanup Verification Package for the 116-DR-6 Liquid Disposal Trench*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at:
<http://www5.hanford.gov/arpir/?content=findpage&AKey=D5623285>.
15. CVP-2000-00015, 2000, *Cleanup Verification Package for the 116-DR-4 Pluto Crib*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at:
<http://www5.hanford.gov/arpir/?content=findpage&AKey=D5623450>.
16. CVP-2000-00016, 2000, *Cleanup Verification Package for the 100-D-12 Sodium Dichromate Pump Station*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at:
<http://www5.hanford.gov/arpir/?content=findpage&AKey=D5623587>.
17. CVP-2000-00018, 2000, *Cleanup Verification Package for the 100-D-52 Drywell*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at:
<http://www5.hanford.gov/arpir/?content=findpage&AKey=D8565696>.
18. CVP-2000-00019, 2000, *Cleanup Verification Package for the 116-DR-7 Inkwell Crib*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at:
<http://www5.hanford.gov/arpir/?content=findpage&AKey=D8503435>.
19. CVP-2000-00024, 2001, *Cleanup Verification Package for the 1607-H2 Septic System*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at:
<http://www5.hanford.gov/arpir/?content=findpage&AKey=D8650014>.
20. CVP-2000-00025, 2001, *Cleanup Verification Package for the 1607-H4 Septic System*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at:
<http://www5.hanford.gov/arpir/?content=findpage&AKey=D5623706>.
21. CVP-2000-00026, 2001, *Cleanup Verification Package for the 116-H-1 Process Effluent Trench*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at:
<http://www5.hanford.gov/arpir/?content=findpage&AKey=D5623911>.
22. CVP-2000-00027, 2001, *Cleanup Verification Package for the 116-H-7 Retention Basin*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at:
<http://www5.hanford.gov/arpir/?content=findpage&AKey=D5624133>.
23. CVP-2000-00028, 2000, *Cleanup Verification Package for the 100-H-5 Sludge Disposal Trench*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at:
<http://www5.hanford.gov/arpir/?content=findpage&AKey=D5624426>.
24. CVP-2000-00029, 2001, *Cleanup Verification Package for the 100-H-21 Reactor Effluent Pipelines, 100-H-22 Effluent Pipeline Leakage, and 100-H-1 Rod Cave*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at:
<http://www5.hanford.gov/arpir/?content=findpage&AKey=D5626735>.
25. CVP-2000-00030, 2001, *Cleanup Verification Package for the 100-H-24 Substation*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at:
<http://www5.hanford.gov/arpir/?content=findpage&AKey=D8836772>.

26. CVP-2000-00031, 2001, *Cleanup Verification Package for the 100-H-17 Overflow, 116-H-2 Liquid Waste Disposal Trench, 100-H-2 Buried Thimble Site, and the 100-H-30 Sanitary Sewer Trench*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at:
<http://www5.hanford.gov/arpir/?content=findpage&AKey=D5626958>.
27. CVP-2000-00032, 2001, *Cleanup Verification Package for the 116-H-3 French Drain*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at:
<http://www5.hanford.gov/arpir/?content=findpage&AKey=D5627056>.
28. CVP-2000-00033, 2001, *Cleanup Verification Package for the 100-D-48:4 Small Cooling Water Effluent Pipelines*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at:
<http://www5.hanford.gov/arpir/?content=findpage&AKey=D8726599>.
29. CVP-2000-00034, 2001, *Cleanup Verification Package for the 100-D and 100-DR Group 3 Pipelines (100-D-48:3 and 100-D-49:3) and 100-D-5 and 100-D-6 Burial Grounds*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at:
<http://www5.hanford.gov/arpir/?content=findpage&AKey=D8726630>.
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Appendix C

Ecological Soil Screening Levels

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C1 Introduction

This appendix presents ecological soil screening levels values for metals, pesticides, chlorinated organic compounds, non-chlorinated organic compounds, and petroleum. Table C-1 presents EPA ecological soil screening levels and WAC-173-340 Table 793-3 values.

Table C-1. Ecological Screening Levels

Hazardous Substance		2007 WAC 173-340 Table 749-3			EPA Ecological Soil Screening Levels ^a				Waste Site Analyses
		Plants	Soil Biota	Wildlife	Plants	Soil Biota	Avian ^b	Mammalian ^b	
Metals (mg/kg):									
	Background								
Aluminum (soluble salts)	NA	50			No specific level; COPC only for soils with pH < 5.5.				
Antimony	5 ^c	5			NA	78	NA	0.27	
Arsenic III	6.5 ^d			7	18	NA	43	46	
Arsenic V	6.5 ^d	10	60	132					
Barium	132	500		102	NA	330	NA	2,000	
Beryllium	1.51	10			NA	40	NA	21	
Boron	NA	0.5							
Bromine	NA	10							
Cadmium	0.81	4	20	14	32	140	0.77	0.36	
Chromium (total)	18.5	42	42	67	NA	NA	26	34	
Chromium VI	NA				NA	NA	NA	130	
Cobalt	15.7	20			13	NA	120	230	
Copper	22	100	50	217	70	80	28	49	
Fluorine	NA	200							
Iodine	NA	4							
Lead	10.2	50	500	118	120	1,700	11	56	
Lithium	33.5	35							
Manganese	512	1,100		1,500	220	450	4,300	4,000	
Mercury, inorganic	0.33	0.3	0.1	5.5					

Table C-1. Ecological Screening Levels

Hazardous Substance		2007 WAC 173-340 Table 749-3			EPA Ecological Soil Screening Levels ^a				Waste Site Analyses
		Plants	Soil Biota	Wildlife	Plants	Soil Biota	Avian ^b	Mammalian ^b	
Mercury, organic	NA			0.4					
Molybdenum	NA	2		7					
Nickel	19.1	30	200	980	38	280	210	130	
Selenium	0.78	1	70	0.3	0.52	4.1	1.2	0.63	
Silver	0.73	2			560	NA	4.2	14	
Technetium	NA	0.2							
Thallium	NA	1							
Tin	NA	50							
Uranium	3.21	5							
Vanadium	85.1	2			NA	NA	7.8	280	
Zinc	67.8	86	200	360	160	120	46	79	
Pesticides (mg/kg):									
Aldrin				0.1					
Benzene hexachloride (including Lindane)				6					
Chlordane		1		2.7					
DDT/DDD/DDE (total)				0.75			0.093	0.021	
Dieldrin				0.07			0.022	0.0049	
Endrin				0.2					
Heptachlor/heptachlor epoxide (total)				0.4					
Hexachlorobenzene				17					
Pentachlorophenol		3	6	4.5	5.0	31	2.1	2.8	

Table C-1. Ecological Screening Levels

Hazardous Substance	2007 WAC 173-340 Table 749-3			EPA Ecological Soil Screening Levels ^a				Waste Site Analyses
	Plants	Soil Biota	Wildlife	Plants	Soil Biota	Avian ^b	Mammalian ^b	
Other Chlorinated Organics (mg/kg):								
Chlorinated dibenzofurans (total)			2.00E-06					
Chloroacetamide		2						
Chloroaniline-3	20	30						
Chlorobenzene		40						
Chlorophenol-3	7	10						
Dichloroaniline-2,4		100						
Dichloroaniline-3,4		20						
Dichlorobenzene-1,4		20						
Dichlorophenol-3,4	20	20						
Dichloropropane-1,2		700						
Dioxins			2.00E-06					
Hexachlorocyclopentadiene	10							
PCB mixtures (total)	40		0.65					
Pentachloroaniline		100						
Pentachlorobenzene		20						
Tetrachloroaniline-2,3,5,6	20	20						
Tetrachlorobenzene-1,2,3,4		10						
Tetrachlorophenol-2,3,4,5		20						
Trichloroaniline-2,4,5	20	20						
Trichlorobenzene-1,2,3		20						

Table C-1. Ecological Screening Levels

Hazardous Substance	2007 WAC 173-340 Table 749-3			EPA Ecological Soil Screening Levels ^a				Waste Site Analyses
	Plants	Soil Biota	Wildlife	Plants	Soil Biota	Avian ^b	Mammalian ^b	
Trichlorobenzene-1,2,4		20						
Trichlorophenol-2,4,5	4	9						
Trichlorophenol-2,4,6		10						
Other Nonchlorinated Organics (mg/kg):								
Acenaphthene	20							
Low Molecular Weight PAHs ^e					29		100	
High Molecular Weight PAHs ^f					18		1.1	
Benzo(a)pyrene			12					
Biphenyl	60							
Diethylphthalate	100							
Dimethylphthalate		200						
Di-n-butyl phthalate	200							
Dinitrophenol-2,4	20							
Fluorene		30						
Furan	600							
Nitrobenzene		40						
Nitrophenol-4		7						
Nitrosodiphenylamine; N-		20						
Phenol	70	30						
Styrene	300							
Toluene	200							

Table C-1. Ecological Screening Levels

Hazardous Substance	2007 WAC 173-340 Table 749-3			EPA Ecological Soil Screening Levels ^a				Waste Site Analyses
	Plants	Soil Biota	Wildlife	Plants	Soil Biota	Avian ^b	Mammalian ^b	
Petroleum (mg/kg):								
Gasoline Range Organics		100	5,000					
Diesel Range Organics		200	6,000					

Notes:

NA = Values not available

Highlighted values are the lowest ecological screening levels for individual hazardous substances.

Exceedance of screening values does not necessarily indicate the existence of risk to ecological receptors. All exceedances must be evaluated in the context of additional lines of evidence for ecological effects following a baseline risk assessment for the river corridor portion of the Hanford Site, which will include a more complete quantitative ecological risk assessment.

- Available on the internet at: www.epa.gov/ecotox/ecoss/.
- Wildlife.
- Background value listed for antimony is Washington State background value. No Hanford Site background value is available.
- The Hanford Site background for arsenic is 6.5 mg/kg. An arsenic cleanup level of 20 mg/kg was agreed to by the Tri-Party Agreement Project Managers for Interim Action as discussed in Section 2.1.2.1 of the 100 Area RDR/RAWP, DOE/RL-96-17, Rev. 6.
- Low Molecular Weight Polynuclear Aromatic Hydrocarbons (LMW-PAHs), (e.g., Anthracene, Fluoranthene, Fluorene, 2-Methylnaphthalene, 3-Methylnaphthalene, Naphthalene, 1-Naphthol, 1-Naphthaleneacetic acid, Phenanthrene).
- High Molecular Weight Polynuclear Aromatic Hydrocarbons (HMW-PAHs), (e.g., 6-Aminochrysene, Benzanthrone, Benzo(a)pyrene, 7,12-Dimethylbenz(a)anthracene, 3-Methylcholanthrene, Pyrene).

Appendix D

Planned Borehole, Test Pit, and Groundwater Characterization Well Locations Relative to Historical Limited Field Investigation Wells

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D1 Introduction

This appendix presents figures providing the locations of planned boreholes, test pits, and groundwater characterization wells to be installed under the scope of this SAP relative to historical limited field investigation (LFI) wells. The actual locations will be determined based on a field walkdown of current site conditions to avoid Hanford Site National Historic restrictions, roads, and other obstructions.

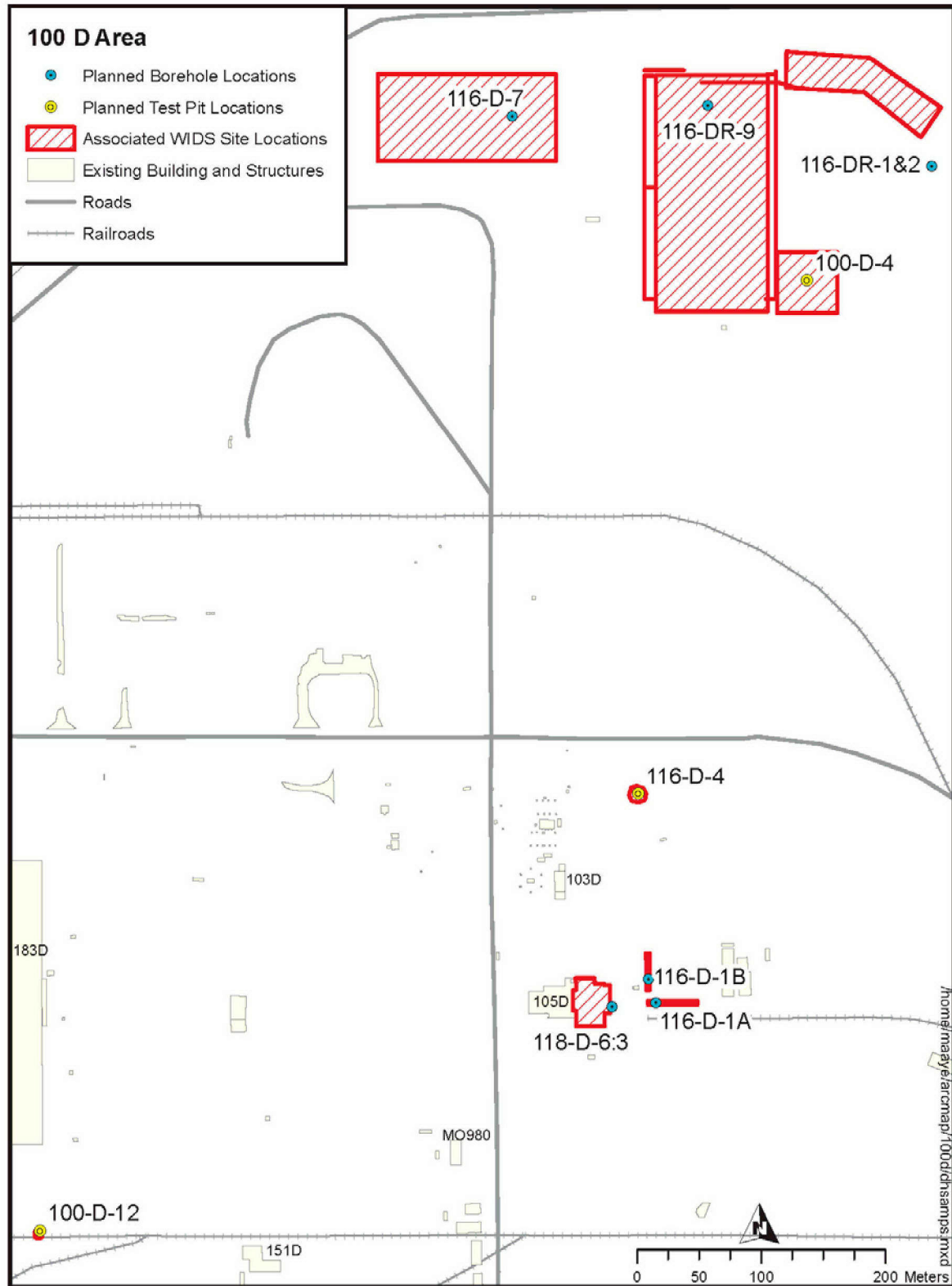


Figure D-1. Test Pit and Borehole Planned Locations for 100-D Relative to Historic LFI Sample Locations

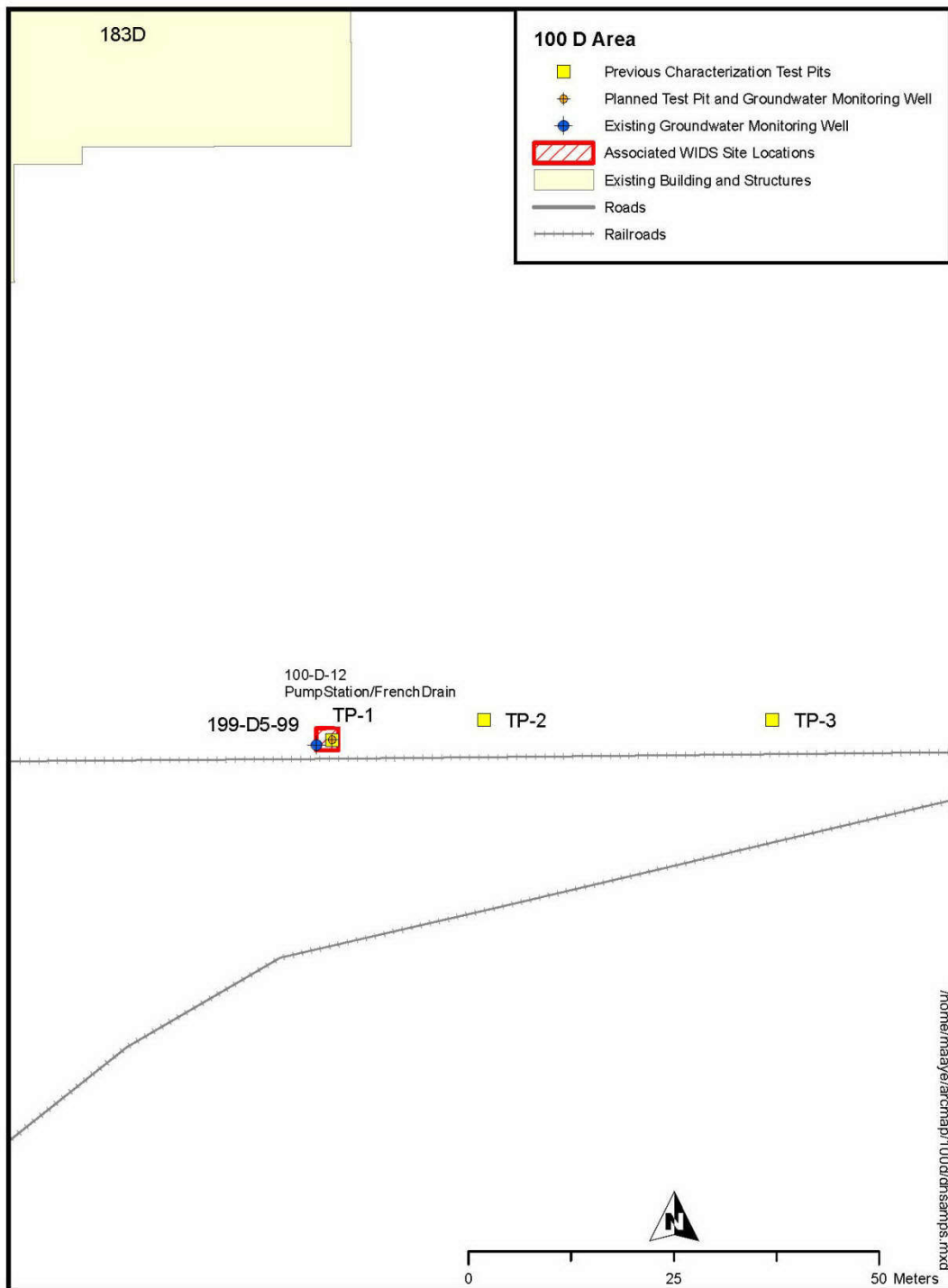


Figure D-2. Planned Test Pit Locations for the 100-D-12 French Drain Relative to Historic LFI Sample Locations



Figure D-3. Planned Borehole Locations for the 116-D-7 Retention Basin, 116-DR-9 Retention Basin, and 116-DR-1&2 Trench Relative to Historic LFI Sample Locations

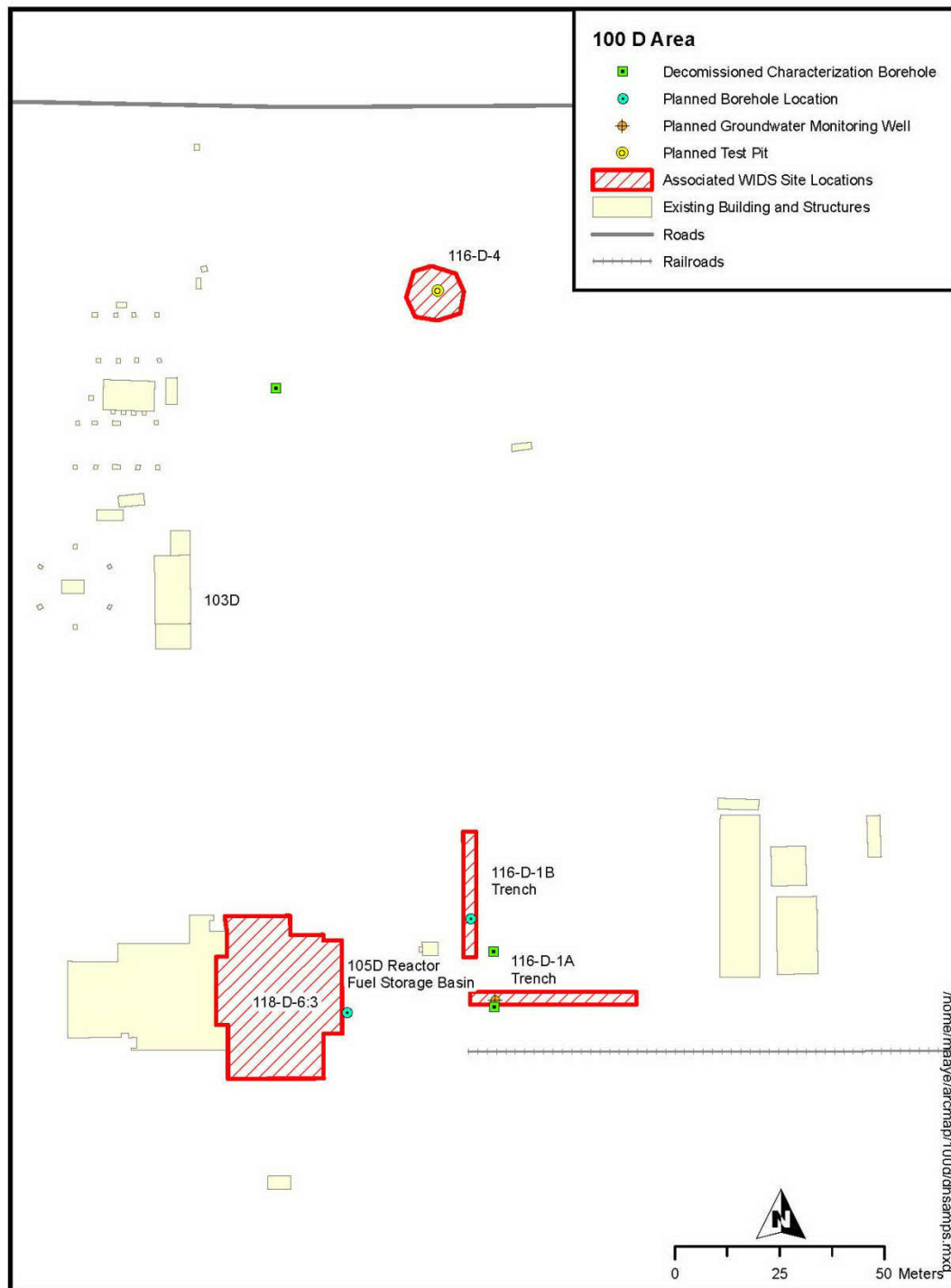


Figure D-4. Planned Borehole and Test Pit Locations for the 116-D-4 Crib, 118-D-6 Reactor Fuel Storage Basin, and 116-D1A/B Trench Relative to Historic LFI Sample Locations

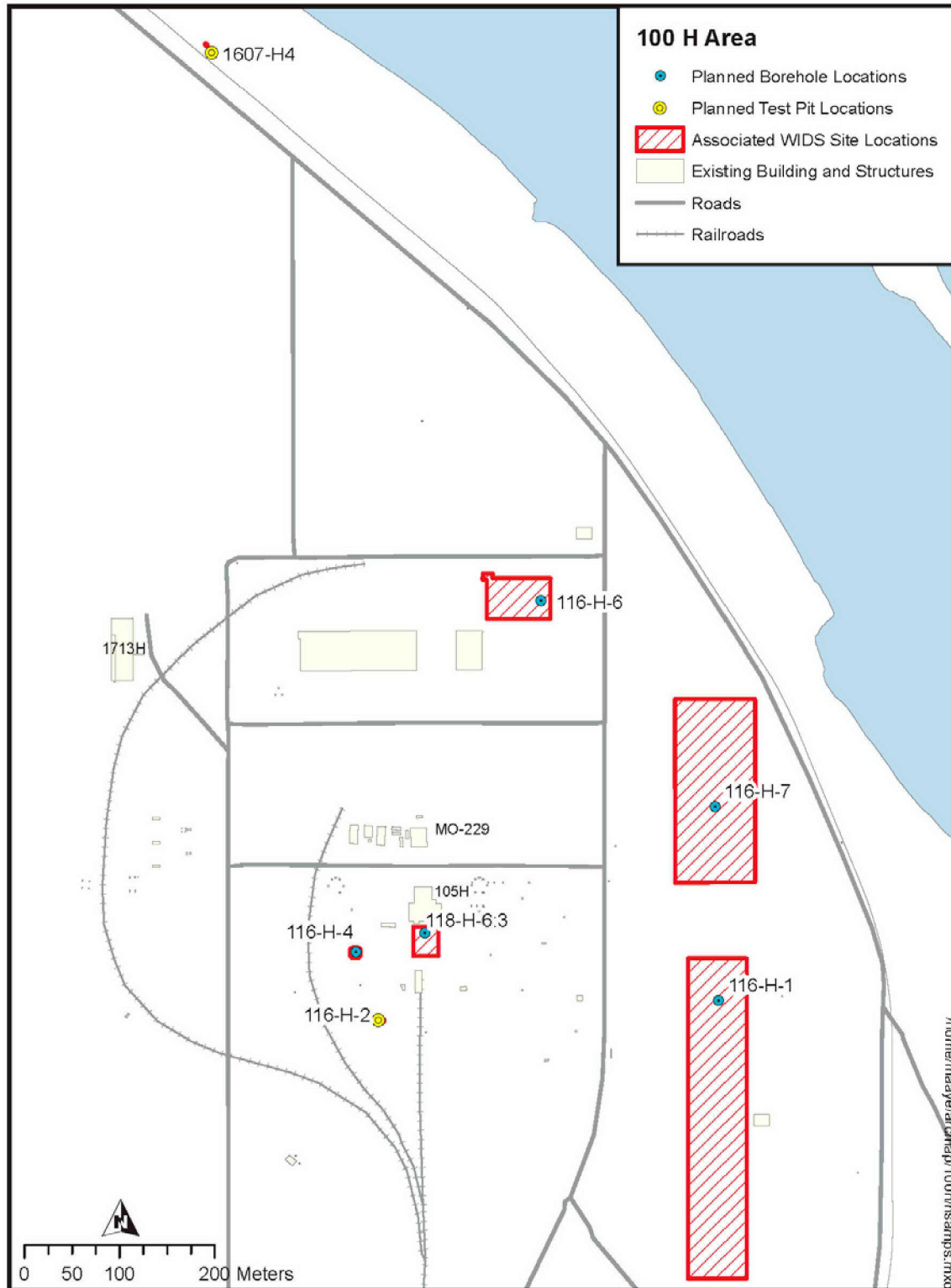


Figure D-5. Test Pit and Borehole Planned Locations for 100-H Relative to Historic LFI Sample Locations

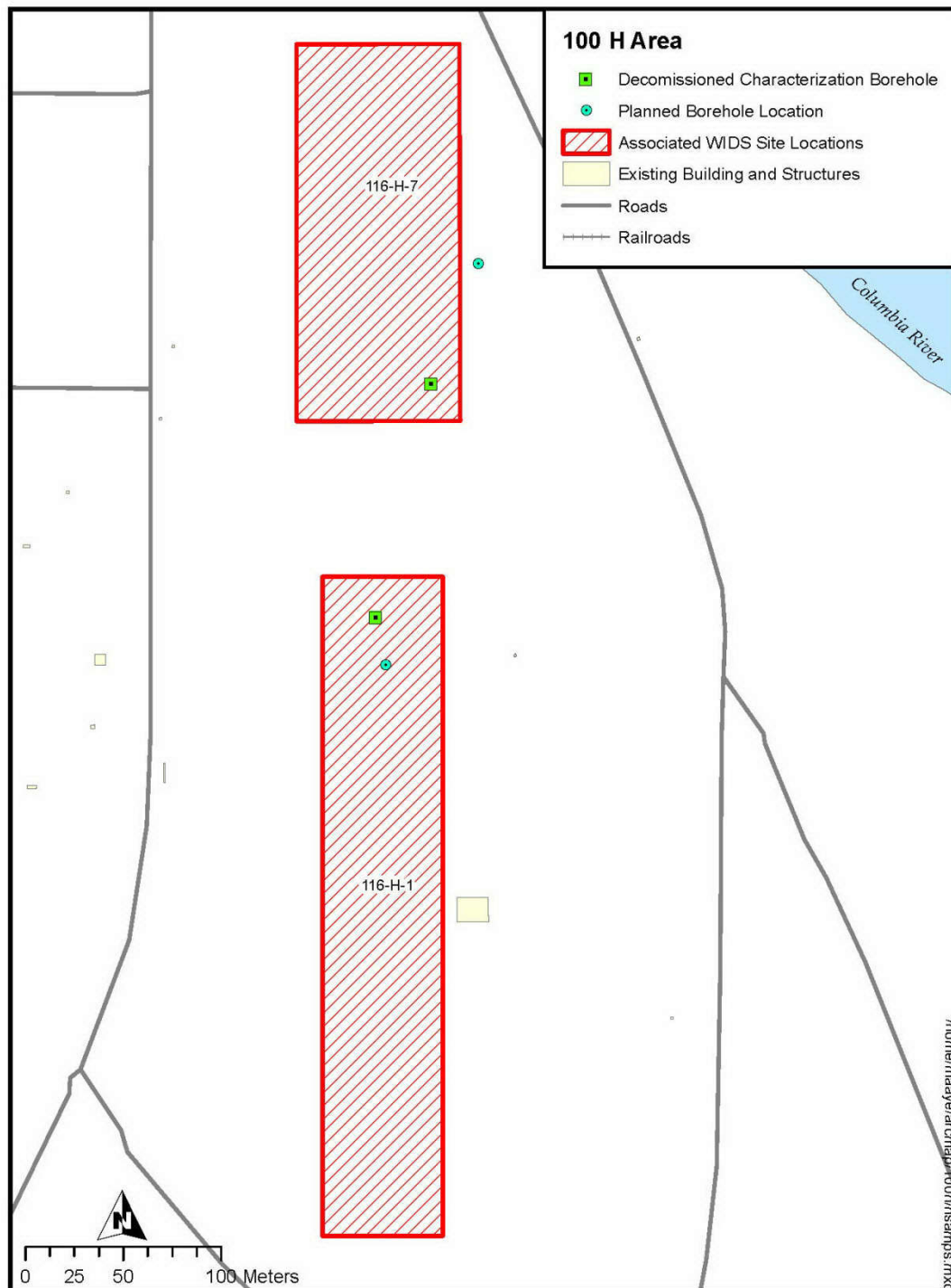


Figure D-6. Planned Borehole Locations for the 116-H-1 Trench and 116-H-7 Retention Basin Relative to Historic LFI Sample Locations

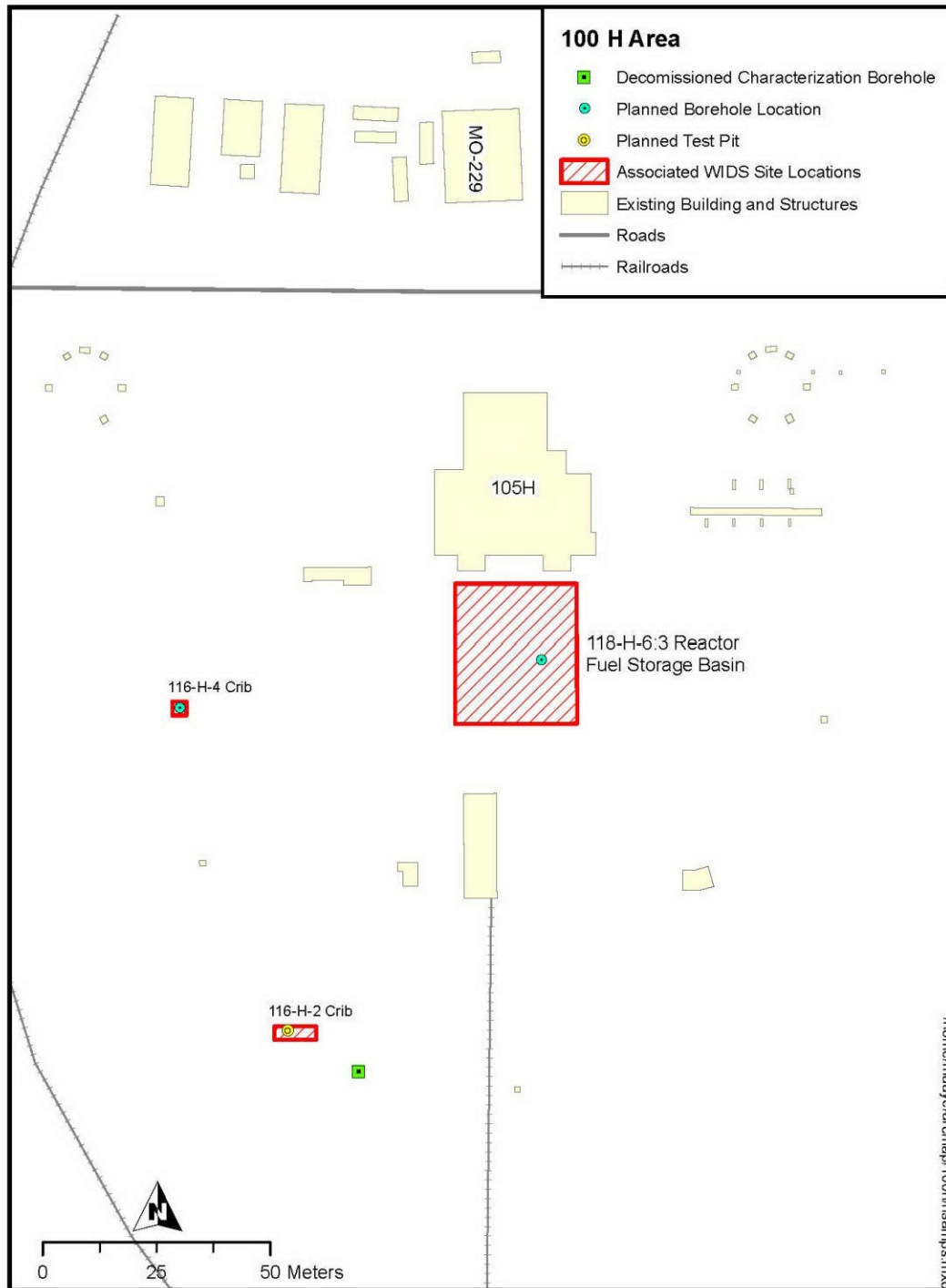


Figure D-7. Planned Borehole and Test Pit Locations for 116-H-4 Pluto Crib, 118-H-6 Reactor Fuel Storage Basin, and 116-H-2 Liquid Waste Trench Relative to Historic LFI Sample Locations

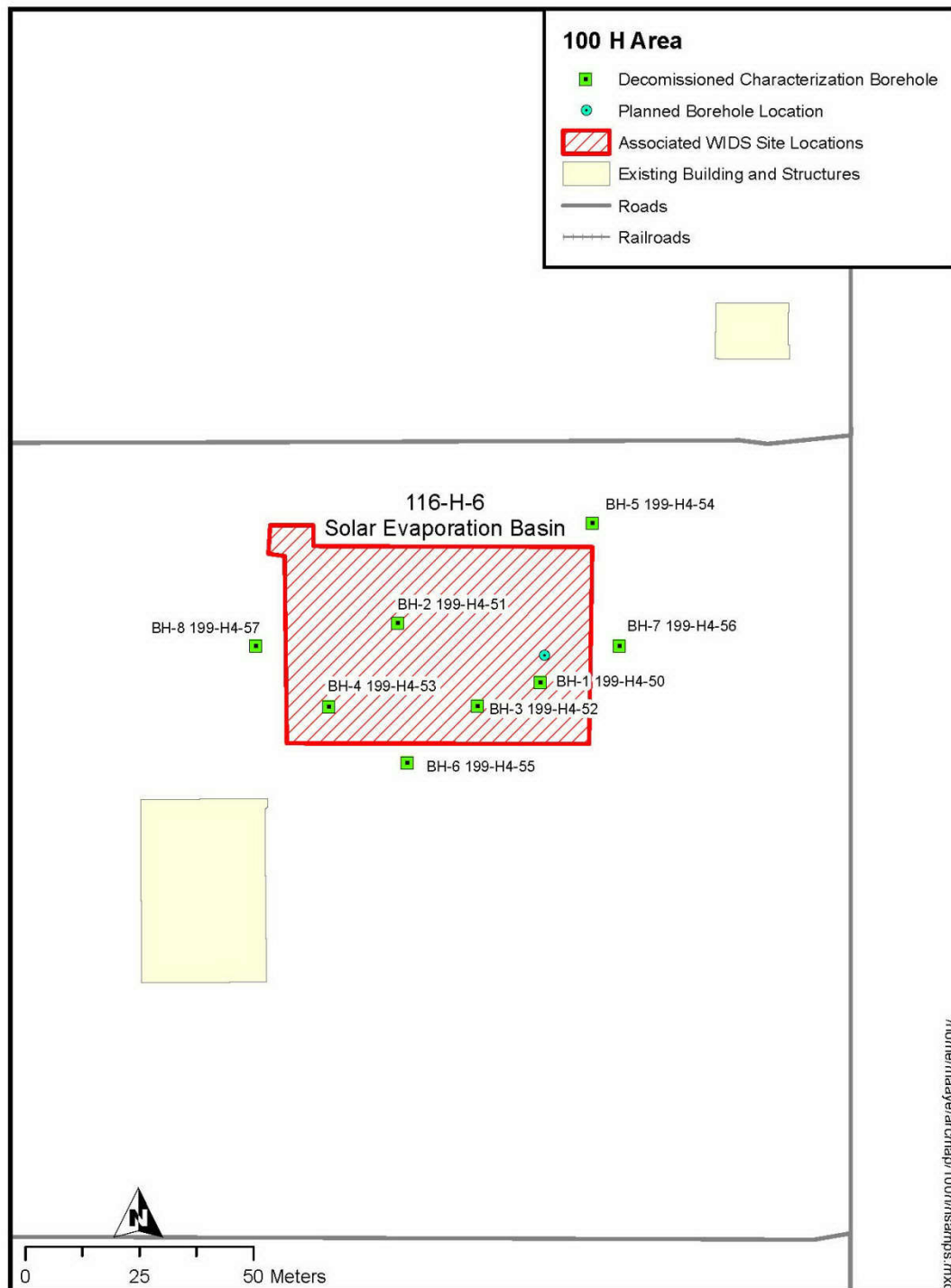


Figure D-8. Planned Location for the 116-H-6 Solar Evaporation Basin Borehole Relative to Historic LFI Sample Locations

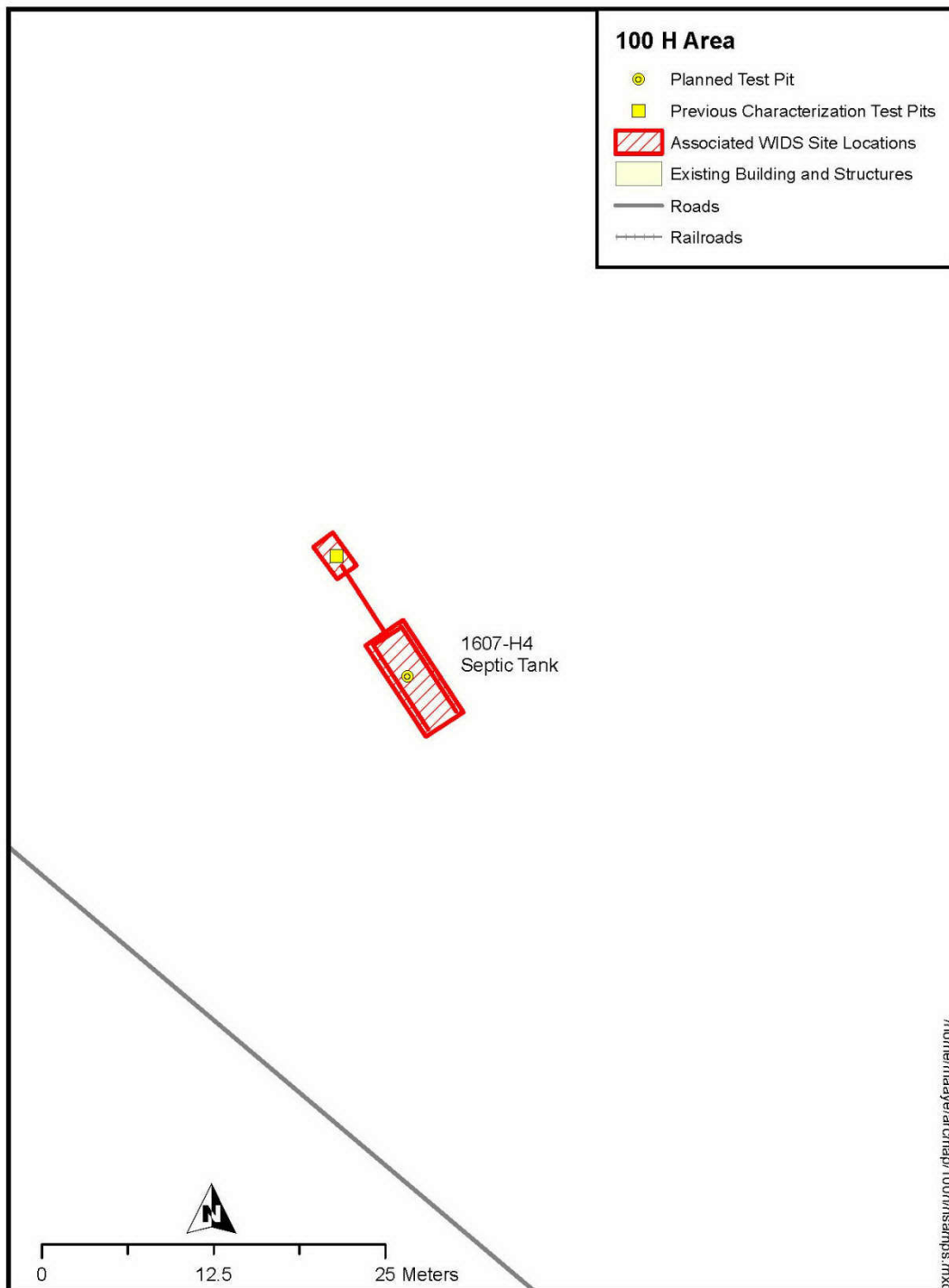


Figure D-9. Planned Location for the 1607-H4 Septic Tank and Drain Field Test Pit Relative to Historic LFI Sample Locations

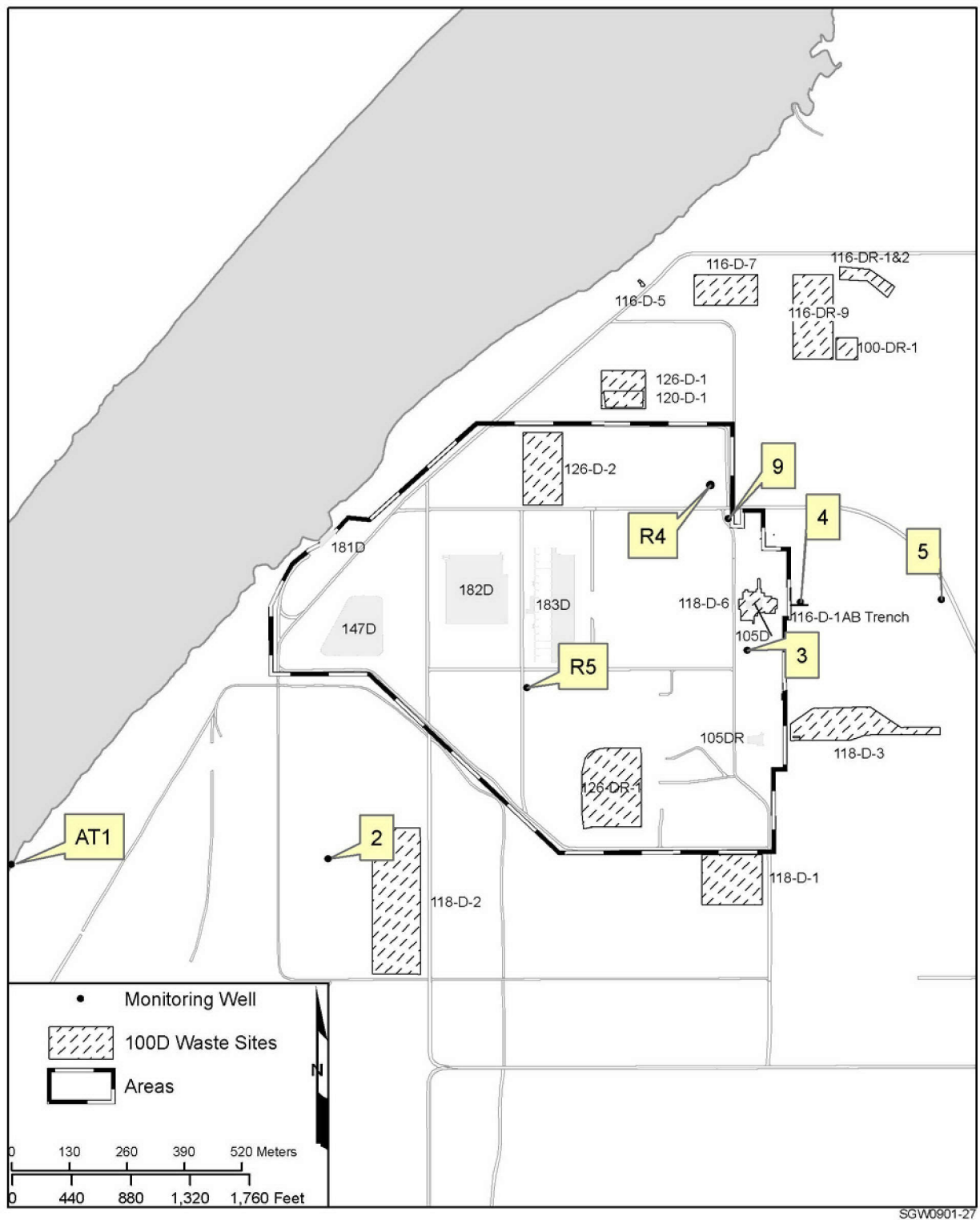


Figure D-10. Planned Location for 100-D Groundwater Characterization Relative to Historic LFI Sample Locations

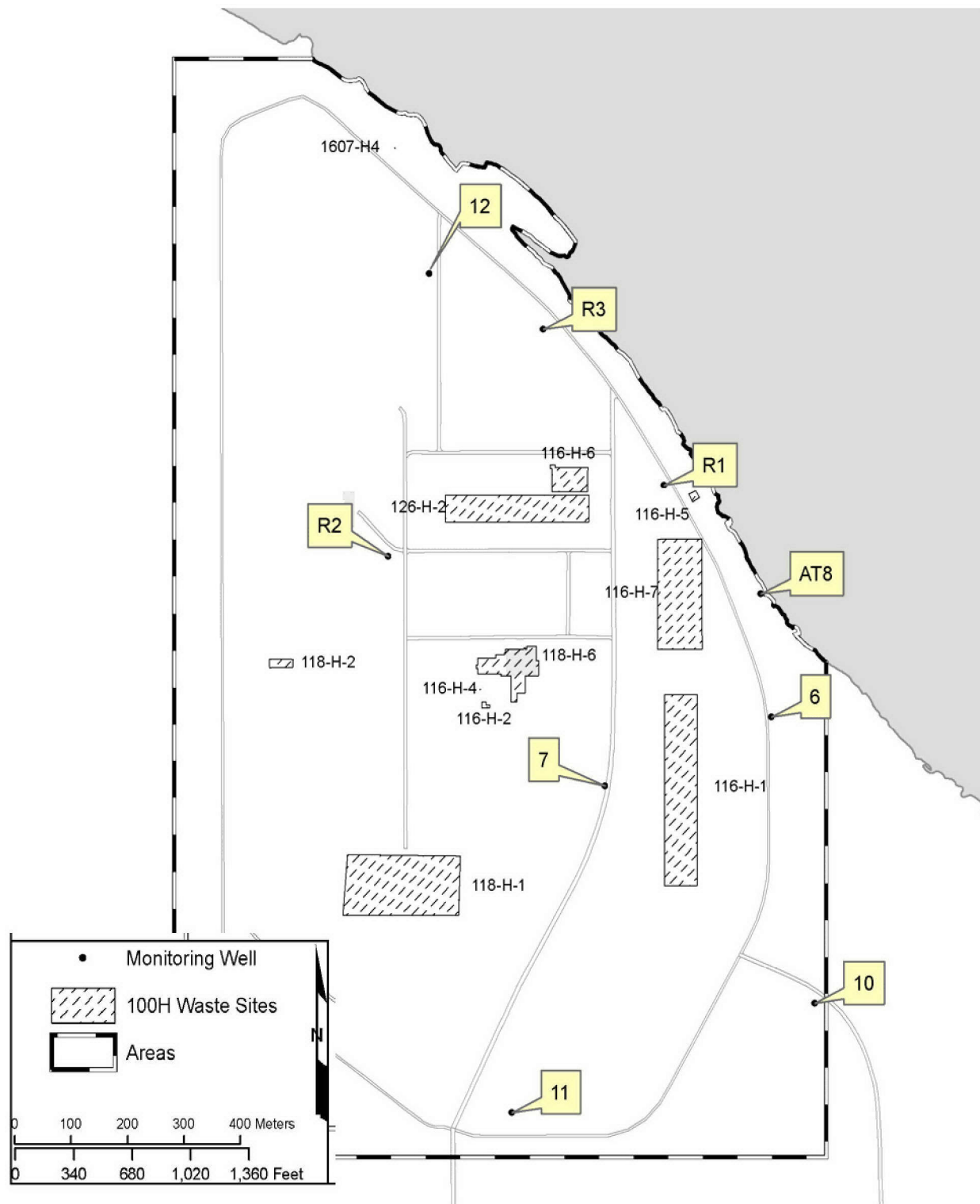


Figure D-11. Planned Location for 100-H Groundwater Characterization Relative to Historic LFI Sample Locations

Distribution

	<u>MS</u>	<u>Quantity</u>
<u>U.S. Department of Energy, Richland Operations Office</u>		
J.P. Hanson	A6-38	69
DOE Public Reading Room	H2-53	1
<u>CH2M HILL Plateau Remediation Company</u>		
J.V. Borghese	H3-21	18
<u>Publications Technical Library</u>	H3-21	1
<u>Washington Closure Hanford, LLC</u>		
R.O. Ovink	H4-21	6
<u>Pacific Northwest National Laboratory</u>		
J.S. Fruchter	K6-96	2
<u>Administrative Record</u>	H6-08	1
<u>Document Clearance</u>	H6-08	1

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